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Fish processing in Africa

PROCEEDINGS OF THE FAO EXPERT CONSULTATION ON FISH TECHNOLOGY IN AFRICA

Traitement du poisson en Afrique

COMPTE RENDU DE LA CONSULTATION D'EXPERTS DE LA FAO SUR LA TECHNOLOGIE DU POISSON EN AFRIQUE

Lusaka, Zambia/Zambie, 21-25 January/janvier 1985

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE

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Proceedings of the FAO Expert Consultation on Fish Technology in Africa

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TRAITEMENT DU POISSON EN AFRIQUE

Compte rendu de la Consultation d'experts de la FAO sur la technologie du poisson en Afrique

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Rome 1986

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PREPARATION OF THIS DOCUMENT

Publication of this supplement to the report of the 1985 FAO Expert Consultation on Fish Technology in Africa held in Lusaka, Zambia, makes available the papers presented at the Consultation. The papers in English have been edited by the Torry Research Station, Aberdeen, UK, and the papers in French by H. Durand, Institut français de recherche pour l'exploitation de la mer, Centre de Nantes, France.

The publication follows the pattern set by the previous Consultation held in Morocco in 1982 when the papers were published as:

FAO, Proceedings of the FAO Expert Consultation on fish technology in Africa. Casablanca,
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PREPARATION DE CE DOCUMENT

La publication de ce supplément au rapport de la Consultation d'experts FAO sur la technologie du poisson en Afrique tenue à Lusaka, Zambie, en 1985, met à disposition les communications présentées à la Consultation. Les communications en anglais ont été mises au point par Torry Research Station à Aberdeen, Royaume Uni, et les communications en français par H. Durand (Institut français de recherche pour l'exploitation de la mer, Centre de Nantes, France).

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ABSTRACT

This publication contains the 54 papers presented during the FAO Expert Consultation on Fish Technology, Lusaka, Zambia, 21-25 January 1985. These papers are divided into the following categories: fish handling, processing methods and products characteristics, prevention of post-harvest losses, marketing of fish and fishery products and fish quality control and inspection.

The Consultation was held to review the progress in fish technology in Africa since the last meeting of this type, held in Casablanca in 1982, to examine current activities of research institutes in different African countries, to identify existing difficulties and obstacles to cooperation, to determine needs and priorities for further research and to elaborate recommendations for a continued cooperative research programme in fish technology in Africa.

RESUME

Cette publication contient les 54 documents présentés à la Consultation d'experts de la FAO sur la technologie du poisson qui s'est tenue à Lusaka, Zambie, du 21 au 25 janvier 1985. Ces documents sont répertoriés comme suit: manipulation du poisson, méthodes de traitement et caractéristique des produits, prévention des pertes après capture, commercialisation du poisson et des produits de la pêche et contrôle de la qualité et inspection.

La Consultation a eu lieu pour réexaminer les progrès de la technologie du poisson en Afrique, depuis la dernière réunion de ce genre qui se tint à Casablanca en 1982, pour étudier les activités courantes des instituts de recherche dans plusieurs pays africains, pour identifier les difficultés existantes et les obstacles à la coopération, pour déterminer les besoins et les priorités pour toute recherche ultérieure, pour élaborer des recommandations pour un programme continu de coopération pour la technologie du poisson en Afrique.

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SESSION 1:

FISH HANDLING/MANIPULATION DU POISSON

A REVIEW OF FISH TECHNOLOGICAL RESEARCH IN ZAMBIA

by

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ABSTRACT

Research of fish technology was carried out during 1965-78, in Zambia, covering fish-handling, fish processing and quality control. The available literature on fish technology is briefly reviewed and the present state of the processing sector is discussed.

1. INTRODUCTION

The fishery potential of Zambia was realized as early as 1938 and development of this valuable resource has formed part of Government activities since then. Although research gained momentum, serious endeavours were diverted to fish processing technology only in the mid sixties, particularly after the establishment of the Central Fisheries Research Institute under an UNDP/FAO funded project in 1966. Much of the contributions on fish processing technology emerged from the activities of this project. This paper briefly reviews the research work carried out on fish handling and processing in Zambia, including the findings of experts and consultants on the state of the processing industry.

2. GENERAL BACKGROUND

Zambia is well endowed with a natural fishery resource comprising rivers (Kafue floodplains, Upper Zambezi and Luangwa), lakes (Tanganyika, Mweru-Luapula, Mweru-Wa-Ntipa and Kariba) and swamps (Bangweulu and Lukanga), in addition to a number of other minor fisheries. The fish production from Zambian waters averaged 54 000 t during the period 1980-83. It has been estimated that up to 80% of the fish caught is marketed in dry form (Beatty, 1969; Clucas, 1976). This does not include the fish consumed fresh at landing places. Traditional processing accounts for about 50% of the fish produced in the country (Beatty, 1969). The country's demand for fish is insatiable.

A possible 20% of the fish landed is spoilt (Clucas, 1976) due to poor handling, processing, packing, transportation and storage. Specific information on the nature of spoilage and the factors responsible for the loss is not yet available.

Fish is processed mostly in the landing centres by the fishermen themselves or by the traders, exclusively through traditional practices of sun drying, smoking or a combination of these two methods depending upon the species of fish and the area. Fish processing practices in Zambia have been earlier reviewed by Beatty and Pike (1965), Clucas (1976), and Clucas and Chamasonde (1977). However, a brief account on the research work carried out on fish processing and the reports of the experts and consultants will be of interest to evaluate the state of the technology available and to identify the gaps in our knowledge. The different methods adopted in the country may be discussed under the following headings.

3. FISH HANDLING

Much of the fish landed in Zambia comes from overnight fishing through gillnetting and light-fishing (purse seines, liftnets and beach seines). As a result the fish gilled or caught during the early hours of the night are in a semi-spoiled state by the time the catch is hauled or landed during the morning. The transport of fish from the fishing ground to the landing centres takes from one to six hours (Watanabe, 1971). Guidelines for better handling storage and transport was provided by Watanabe (1971a). The fish handling practices in Zambia do not include gutting and as a result, the quality of the fish further deteriorates. It is known that careless of inadequate gutting or washing in dirty water will do more harm than good (Cole, 1975). However, Watanabe (1966) showed that gutting improved the quality during iced storage of fish. Unfortunately, gutted fresh fish are not very acceptable to Zambian consumers.

Use of ice is restricted mostly to fresh fish traders and often the quantity of ice used is not proportional to the fish stored (1:1) in the containers resulting in higher temperatures of over 9°C. The quality of fresh fish by the time it reaches the market is not good (Williams, 1977). A comparative study on the melting rate of flake and block ice under various locally available insulations was carried out (Watanabe, 1966). Watanabe (1966a) suggested the use of a lower temperature of 5°C combined with better washing and gutting for improving the keeping quality of iced Kariba bream (Tilapia mortimeri) for a storage life up to 14 days. Studies were also carried out on physical, chemical and organoleptic characteristics of fresh bream, mud-sucker, tiger-fish and barbels landed from Lake Kariba and their yields after gutting and filleting (Watanabe, 1971b). It was also observed that due to total lack of or insufficient icing, the freshness of the kapenta (sardines) arriving at the freezing plants in Mpulungu (Lake Tanganyika) were not of the required quality (Watanabe, 1966b). Early hauls tend to show a brownish discoloration and belly burst with oozing viscera which gives a very unappealing appearance to the products after freezing and sun drying. This tendency was also observed in the catches of kapenta from Lake Kariba. Watanabe (1966b) suggested improved handling methods for frozen Tanganyika sardines to overcome these problems. Watanabe and Cabrita (1971) also provided guidelines for handling fish during catching, transport and marketing.

4. SUN DRYING

The kapenta from Lake Tanganyika/Kariba and chisense (comprising a mixture of clupeids and minnows) from Lake Mweru (Luapula), Mweru-Wa-Ntipa and Bangweulu are processed exclusively by sun drying. These sundried, small fish constitute the most important source of animal protein, particularly for the rural population of Zambia. Except for the kapenta from Kariba, the drying is mostly carried out on the ground, sandy beaches and in some areas on concrete slabs or cemented floors. A weight loss of up to 10% was reported by Beatty (1969) in the poorly dried kapenta of Lake Tanganyika, due to sand and dirt. Sun drying of split fish for two to three days prior to smoking is common for bream in Mweru-Wa-Ntipa, Bangweulu and Lukanga. In Bangweulu and Lake Tanganyika small cichlids and other large fish are sun dried for a period of one to two weeks before they are sold (Clucas, 1976). Pests during the traditional drying period include chicken, dogs, ants and flies (Scullion, 1984). The rains result in contamination of the fish and prolong the drying process. Use of raised sloping racks with a provision of polythene sheeting for covering the fish during the rainy season was proposed by Watanabe and Cabrita (1971). Further improvement suggested for the sun-drying of kapenta includes brining period of 10-20 minutes followed by 16-18 hours drying on raised racks for a storage life up to three months (Watanabe, 1971c).

5. USE OF SALT

There is a general belief that salted fish is unacceptable to the Zambian consumer. On the contrary, the findings of Watanabe and Dzekedzeke (1971) established through taste panel studies of salted and smoked and unsalted and smoked fish that the preference is for a lightly salted product. Proctor (1972) also found a taste preference among Zambians for brined fish. These studies also revealed that salt increases the yield by weight and minimizes losses due to fragmentation. Watanabe (1971a) observed that the growth of bacteria on fish was strongly affected by salt concentration ranging from 2.5 to 10% and suggested a salt content of 10% in the finished products, which is within the acceptable limits in the country. Hence a light brining before hot smoking was proposed for improving the quality of the product and for longer storage life (Watanabe and Cabrita, 1971).

A practice of dry-salting is prevalent in the Mweru (Luapula) fishery and the product finds its way mostly to neighbouring Zaire. In recent years dry-salted fish produced from Lake Mweru is sold in the urban market in Zambia also suggesting a shift in the consumer preference. In Mweru and occasionally in Bangweulu light brining before sun drying and smoking is practised by some fishermen.

In Zambia salt is expensive and not always available in all the fishery areas.

6. DRY SMOKING

Hot smoking is the most popular method of processing fish in Zambia. Traditionally, the fish is smoked on pits or on raised smoking "tables", where the control of heat is difficult and at times impossible. The method also poses problems during the wet season and is hazardous under a thatched roof. Watanabe and Joeris (1967) proposed a drum-smoker for processing the catch of an individual fishermen, to overcome the above difficulties. The limitation of the method was the quantity that can be processed at one time. Watanabe and Cabrita (1971) suggested the layout for a smoking kiln for a medium or large-scale smoking operation under rural conditions, with guidelines for the preparation under rural conditions, with guidelines for the preparation of salted and dry-smoked fish. Clucas (1976) considering the merits and demerits of various types of smoking equipments, recommended mud and pole and Ivory Coast smoking kilns as suitable for Zambian conditions. A basic design for the construction of these structures was also provided. The application of liquid smoke was proposed by Yamamoto (1975) and some preliminary work was initiated, but the results were inconclusive.

Shortage of wood fuel in some of the fishery areas, particularly in the swamp fisheries of Bangweulu and Lukanga is a serious problem and in such situations a combination of sun drying and smoking/application of liquid smoke might prove a suitable alternative. Scullion (1983) advocated an improved method of brining followed by smoking and sun drying for Alestes macrophthalmus of Mweru (Luapula) to improve the quality of the product and its shelflife.

7. FREEZING AND CANNING

The development of the frozen fish trade in most developing countries is toward export. But in Zambia, frozen fish is produced exclusively for domestic markets. Large scale freezing is restricted to the Lake Tanganyika fishery. Kapenta and a species of perch (Lates stappersii) constitute the important species being frozen at present. A limited quantity (50 t) of frozen fish fillets from Tanganyika perches are also being produced every year. The quantity of fish frozen in 1984 was close to 4 000 t (Subramaniam, 1985).

In recent years canned fish consisting mostly of kapenta and a small proportion of bream and Lates stappersii has been produced by two companies in the country. The production of canned products is estimated at 500 t per year. Though the quality of the product is improving strict adherence to quality control measures would ensure wider acceptance not only among the local consumers but also in the export market in neighbouring countries.

8. STORAGE AND LOSS DUE TO INSECT INFESTATION

The storage period of fish in the warehouse is short in Zambia due to the heavy demand for the commodity. However, the fish trader often spends 6-8 weeks in the fishery area for collection of the fish before he transports it to urban areas. A weight loss of 5-10% during long storage in traditional packing of kapenta was recorded by Watanabe (1971c). Much of the insect infestation takes place during the collection period. The Department of Fisheries provides roofed sheds for the storage of dried fish in the major fish landing centres. Bundles of fish are stacked on the floor and no insecticidal treatments are carried out in the premises. Watanabe and Cabrita (1971) estimated that 10% of the fish produced are spoiled due to beetle infestation. Out of 85 dried chisense samples examined during storage in Lake Mweru (Luapula) fishery 45% were found to be infested by beetle (Scullion, personal communication). An emulsion containing 0.018% of pyrethrin and 0.036% of Piperonyl butoxide was found to be effective in preventing infestation by Dermestes alter and D. maculatus for a storage period of 8-12 weeks (Proctor, 1972). However, pyrethrin is expensive and there is a need to formulate a cheaper and effective insecticidal dip for the prevention of loss due to insect infestation.

9. QUALITY CONTROL

There are no quality control regulations in the country for fish and fishery products. An examination of the quality of dried Lake Tanganyika sardines arriving at Lusaka markets was carried out to obtain background data (Watanabe, 1971d). Quality standards for the products based on sensory assessment of appearance, smell estimation of water, salt content and pH value were established (Watanabe and Choongo, 1971). Similarly, the market quality of split, dried, smoked bream (Tilapia spp.) was evaluated by chemical, bacteriological and organoleptical examination, to obtain information for the development of national quality standards for the commodity (Watanabe, 1972). Watanabe and Dzekedzeke (1969) recommended standards for smoked bream based on pH, fish size, appearance, smell scores and percentage of water for possible future use by fish inspection services in the country.

Chemical, bacteriological and sensory examinations of split, dried, smoked bream were conducted and organoleptic scores were discussed with regard to their annual averages and seasonal variations (Watanabe, 1972). Watanabe (1971a) carried out a qualitative and quantitative study on the bacteria of fresh fish landed in Lake Kariba/Tanganyika and identified the salt and temperature tolerance of the isolates.

10. THE IMPACT OF FISH PROCESSING RESEARCH ON THE INDUSTRY

There have been substantial efforts diverted toward fish technological research in Zambia. The technology thus developed was in most cases simple and easily adaptable. However, a critical evaluation of the impact of the research findings in improving the processing industry would reveal that very few techniques have been adapted by the fishermen or the fish traders. The only noticeable improvement is in respect of kapenta from Lake Kariba. The operators in this sector use raised racks for drying and in some cases brine their early catches to improve the quality. Since 1967 the Fisheries Department has established seven simple processing plants in the important fishing areas. These plants were meant to impart training to fishermen on better methods of processing and to provide a readily available buyer for their catch at landing centres. The trader also would be in a position to process larger quantities of fish, more economically, reducing the storage period and consequent losses. Processing in a centralized plant also has the advantage of better quality control (Cabrita and Watanabe, 1971). Unfortunately, most of these processing plants are not being utilized by the fishermen or the fish traders. It is difficult to justify and explain to the fishermen the need to invest more money to produce a better product when there is no price incentive The studies by Yamamoto (1975) in the Kafue floodplain fishery revealed that the net earning of a fisherman is reduced after processing compared to sale of fresh fish. Whenever possible, the fisherman would prefer to sell his catch fresh. But, in situations where the fishing grounds/villages are located far away from traders, he is constrained to process the catch by himself. Any improvement on the processing method would only add to the cost and reduce the net earnings. Therefore, a pricing policy based on the quality of the product and provision of basic requirements like ice, salt, etc., at reasonable costs in the landing centres appears to be the logical approach to tackle some of the problems experienced by the processing sector. The available facilities in the remote fishing villages are not conducive to bring about any improvement in the processing methods. Given a choice, a fisherman would endeavour to acquire an outboard engine or a fibreglass boat rather than invest his money in smoking kiln as he is well aware that the larger quantity of fish caught will compensate for the additional investment especially in the prevailing conditions. In these circumstances, a differential pricing system based on the quality of the fish and stringent quality control measures through fish inspection agencies coupled with extensive consumer education can only change the attitude of fishermen and the small fish traders.

Wastage of fish due to non-acceptance in the consumer market is uncommon in Zambia. Watanabe's (1974) study on retail prices of split, smoked, dried bream and dried Lake Tanganyika sardines indicated that the prices were affected by season and size of the product but not by the quality in terms of appearance and smell of the uncooked product. The consumer has to be educated on the importance of the quality of fish, particularly the losses in the nutritive value of fish due to improper handling and processing methods.

The recent improvements in the road communication network for the northern lakes through feeder roads are believed to have increased to volume of trade of fresh fish and minimised the loss of cured fish due to storage and transport. A critical assessment of the impact is yet to be made.

11. CONCLUSION

Although extensive work on fish handling and processing has been carried out in Zambia, much of the technologies developed were not utilized by the fishermen or the fish traders. This is not because the technologies were inappropriate or the extension services of the Department were ineffective, but because of socio-economic constraints on the fishermen, lack of consumer education and quality control regulations.

There are several areas which need further research inputs. These include assessment of loss in processed fish during storage and distribution, identification of the causes of such losses and suggestions for preventive measures, analyses of quality of the smoke and suggestions regarding proper firewood to be used for fish processing, studies on the quality of the canned and frozen fish products and establishment of standards, development of better processing methods for some of the fish species like Lates stappersii, studies on the wastages due to insect infestation and preventive measures, etc.

The need for a fish inspection and quality control programme for both traditional products and for frozen and canned products is glaring. A code of practice for handling and transport of fish is being drafted in the country. However, the implementation of the codes at catching and landing seems impracticable, considering the lack of basic facilities (adequate supply of ice, salt, clean water, and storage facilities) in most of the fish landing centres. Cooperative ventures by groups of fishermen under the umbrella of Provincial Cooperative Unions in fish processing (making use of the Departmental processing yards) and marketing and distribution is therefore recommended. These cooperatives should be in a position to distribute not only the fishing and fish processing requisites but also other essential commodities at reasonable costs, eliminating exploitation by middlemen and thereby contributing to the socio-economic uplift of the fishermen.

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LA TECHNOLOGIE DU POISSON EN MAURITANIE

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RESUME

Ce document décrit les méthodes de manutention, de transformation et de commercialisation du poisson en Mauritanie. Les problèmes des pêches artisanale et industrielle sont étudiés séparément. Des données sur la production, la consommation et le prix au détail sont fournies.

En Mauritanie différents types de technologie du poisson sont pratiqués selon qu'il s'agisse de:

1. la pêche à grande échelle, ou pêche industrielle:
2. la pêche à petite échelle, ou pêche artisanale.

1. TECHNOLOGIE INDUSTRIELLE

Il s'agit dans ce premier cas de la congélation, de la surgélation et du conditionnement du poisson. Les industries pratiquant ces technologies sont implantées à Nouadhibou. La manutention est assurée dans les normes avec du personnel qualifié et des équipements modernes tels que des caisses de manutention en plastique. Des caisses spécifiques sont utilisées pour la conservation du poisson à l'état congelé par toutes les sociétés de congélation. Ces dernières disposent d'installations modernes et de grandes capacités de stockage. Néanmoins, l'une d'entre elles, la SIGP (Société industrielle de grande pêche), transforme le poisson frais en salé/seché ou en séché, soit deux traitements différents. D'autres par contre font de la farine de poisson.

2. TECHNOLOGIE AU NIVEAU ARTISANAL

Dans ce second cas les moyens de conservation mis en place sont jusqu'à ce jour insuffisants. Deux chambres froides d'une capacité de stockage de 20 tonnes chacune, de deux fabriques de glace, l'une produisant des barres de 25 kg et l'autre de la glace en paillettes (10 tonnes/jour) sont disponibles. Ces installations sont implantées à la plage de débarquement de Nouakchott. La fabrique de glace en paillettes a été commandée et implantée pour la SPPAM (Société pour la promotion de la pêche artisanale), tandis que les installations frigorifiques et la fabrique de glace en barre sont issues de la Coopération mauritano-japonaise. Toujours est-il qu'un particulier, opérateur dans la pêche artisanale, dispose de deux chambres froides, l'une pour la congélation, l'autre pour le stockage.

Notons, toujours à Nouakchott, l'existence de quelques poissonneries modernes, certaines ne vendant que du poisson frais, d'autres commercialisant le frais et le congelé. La transformation des produits de mer est appliquée, mais toujours de façon traditionnelle, c'est-à-dire fermenté séché, salé/séché et fumé. Dans ce dernier cas, le traitement ne concerne qu'une espèce bien déterminée et n'est pratiqué qu'à petite échelle.

Dans d'autres petits villages de pêcheurs, en particulier ceux des Imraguens, les mêmes traitements traditionnels sont pratiqués. S'y ajoutent le traitement de la poutargue et de l'huile de poisson. La production de poisson frais des trois villages Imraguens situés au nord de Nouakchott est acheminée quotidiennement à la capitale pour écoulement. Pour les autres localités Imraguens des environs de Nouadhibou, les pêcheurs ayant de constants problèmes d'écoulement de leur poisson à l'état frais et n'ayant aucun moyen de conservation (frais ou congelé), transforment leur production en salé/séché écoulable à Nouakchott. Malheureusement, les transports sont loins d'être fréquents.

A Nouadhibou une partie de la production artisanale est vendue sur le marché pour la consommation locale, tandis que l'autre partie, généralement des espèces nobles, est vendue aux sociétés de pêche pour conditionnement et exportation. Néanmoins, certaines espèces sont traitées en fermenté/séché.

2.1 Manutention et maintien de la qualité du poisson frais

Au niveau de l'exploitation artisanale, la manutention du poisson reste à améliorer. Le poisson est débarqué sur la plage par le pêcheur et après achat du produit, les détaillants des marchés locaux procèdent au partage de la production sans aucune précaution ce qui nuit à la présentation future sur le marché.

La conservation à l'état frais se fait dans des caisses en bois conçues en "isotherme". Le produit y est disposé en couches alternées avec de la glace. Ce même système est appliqué dans les poissonneries modernes qui sont encore peu nombreuses. L'acheminement du poisson frais vers les localités désenclavées, se fait en camionnettes 404, le mode de conservation restant le même; néanmoins quelques barres de glace sont conservées intactes ce qui permettra au mareyeur arrivé à destination de maintenir la qualité du poisson jusqu'à son écoulement total. Cette méthode prévaut par le simple fait que les centres de consommation ne disposent pas jusqu'à présent d'infrastructures d'accueil leur assurant une garantie de conservation. Il est à préciser, que la SPPAM a mis sur place à la plage de débarquement trois minibox pour le poisson frais, et dispose de ses camions frigorifiques tous terrains pour la distribution du produit congelé.

2.2 Méthodes traditionnelles de transformation et caractéristiques du produit

Seules les méthodes traditionnelles de transformation énumérées ci-dessous sont pratiquées de façon régulière.

- Fermentation/séchage;
- séchage;
- salage/séchage;
- fumage (en très petites quantités).

2.2.1 Fermentation/séchage

Le poisson subissant une fermentation/séchage est le plus souvent celui qui est en cours d'altération ou celui qui n'est pas apprécié à l'état frais par le consommateur (poisson chat ou mâchoiron) ou le produit issu d'une surproduction et qui n'a pas trouvé d'acquéreur.

Le poisson est étêté, éviscéré, tranché puis passé dans une saumure pour la fermentation. La durée de fermentation varie entre 12 et 24 heures suivant l'espèce du poisson (poisson gras ou poisson maigre). Après saumurage, le poisson est rincé dans de l'eau de mer avant d'être déposé pour le séchage sur des claies en bois recouvertes d'une nappe de filets. La durée du séchage varie en fonction de l'intensité des rayons solaires et de l'espèce du poisson. Le produit est souvent retourné pour uniformiser le séchage. Bien qu'étant une méthode traditionnelle de transformation, cette technique donne généralement de bons résultats. Il faut néanmoins toujours compter un faible pourcentage de perte causé par l'infestation des insectes.

2.2.2 Séchage

Ce type de transformation nécessite une matière première en très bon état de fraîcheur.

Le poisson est étêté, éventuellement écaillé ou pas, éviscéré, tranché, lavé et bien rincé à l'eau de mer pour supprimer toutes traces de sang. L'arête centrale est ôtée. La phase de séchage a lieu directement après rinçage; dans ce cas, il n'y a donc pas fermentation. Tout comme pour le fermenté/séché, la durée du séchage varie en fonction de l'intensité des rayons solaires et de l'espèce du poisson traité. Par cette méthode, les pertes sont nulles et la conservation très longue.

2.2.3 Salage/séchage

Tout comme le poisson séché, le salé/séché nécessite aussi du poisson frais. Dans ce cas, un certain nombre d'espèces sont utilisées: les espèces nobles, telles que les trois espèces de mérou, les daurades, les courbines, les capitaines et otolithes ainsi que certaines espèces de requins comme l'émissole, la roussette, etc. Le poisson, est étêté, éviscéré, tranché, l'arête centrale est enlevée. Il est ensuite lavé à l'eau de mer additionnée de sel, jouant le rôle d'une saumure légère. Le poisson est bien rincé pour supprimer toutes traces de sang. Ce n'est qu'après ces opérations préliminaires que le poisson est étalé pour égouttage, puis salé au sel sec. Le salage et le séchage durent tant que des traces d'humidité sont présentes. Les caractéristiques du produit fini sont généralement satisfaisantes.

2.2.4 Fumage

En Mauritanie, le fumage du poisson n'est guère pratiqué, sinon par quelques femmes d'origine guinéenne ou sénégalaise de la Casamance. Elles le pratiquent soit à domicile, soit à la plage de débarquement. Elles ne traitent qu'une seule espèce de poisson, le mâchoiron à raison de 80 à 100 kg par jour.

Le produit fini est vendu sur le marché local à de rares consommateurs. Leur méthode de traitement est simple et traditionnelle. Après collecte du produit au moment du débarquement, le poisson est ouvert par le dos sur toute sa longueur de la mâchoire supérieure jusqu'à la nageoire caudale. Après tranchage, le poisson est débarassé de ses viscères, bien lavé à l'eau puis mis à égoutter.

Le fumage est pratiqué soit dans un four construit en parpaings, soit dans un tonneau où sont enflammés des copeaux de bois. Le poisson est suspendu, ou posé sur un support en grillage fixé dans la barrique. Une fois le feu allumé, toutes les ouvertures sont fermées pour éviter des fuites de chaleur et de fumée. Le fumage dure environ de 12 à 16 heures.

A Nouadhibou, le Centre national de recherches océanographiques et de pêche, dispose d'un four expérimental pour le fumage. Des tests y sont faits concernant un certain nombre d'espèces, qui après fumage sont emballées sous vide.

A Nouakchott, cette activité peut se développer car le site de débarquement s'y prête et le poisson, en particulier les petits pélagiques, tels que sardinelles, chinchards, etc., y abondent. L'inconvénient majeur est que le poisson fumé n'est pas très estimé et méconnu des consommateurs mauritaniens. Ceci ne devrait cependant pas être un obstacle au développement de cette technique en Mauritanie, car là où est consommé le poisson fermenté/séché, le fumé peut l'être aussi; il faudrait seulement faire connaître ce produit aux consommateurs pour qu'ils puissent l'apprécier.

En Mauritanie, les pertes de poisson sont surtout enregistrées au niveau de la pêche industrielle, les chalutiers procédant souvent à des rejets en haute mer. Au niveau de la pêche artisanale, les rejets de poisson existent mais sont rares. En période de surproduction de petits pélagiques, il arrive que le pêcheur se retrouve avec des invendus. Le séchage et le fumage n'étant pas pratiqués avec ces espèces, il ne pourra que rejeter son produit.

3. COMMERCIALISATION DU POISSON EN MAURITANIE

La pêche artisanale à Nouakchott revêt une importance considérable. Elle assure actuellement la quasi totalité de l'approvisionnement des populations, la pêche industrielle étant orientée vers l'exportation.

Les plus grands centres de consommation sont: Nouakchott, Boghé, Kaédi, Rosso; les centres secondaires: Sélibaby, Ayoun El Atrouss, Atar, Aleg, Diowol, Bababé, Tékane et Akjoujt.

Vu l'enclavement de certaines de ces localités, seul le poisson fermenté/séché ou séché peut y être acheminé. Même pour les localités accessibles, le coût de la location d'un véhicule pour expédier du poisson frais ou congelé est très élevé:

- Nouakchott - Rosso 204 km de route goudronnée = 4 000 UM
- Nouakchott - Boghé 320 km de route goudronnée = 8 000 UM
- Nouakchott - Kaédi 425 km (dont une partie par piste) = 13 000 UM

Certains mareyeurs - expéditeurs - disposent de leur propre véhicule et assurent un approvisionnement régulier. Ils sont hélas peu nombreux. Les autres mareyeurs ne peuvent procéder à leur expédition qu'à condition de trouver un véhicule disponible.

Toutes les espèces nobles et les petits pélagiques sont consommés, mais il faut tenir compte du pouvoir d'achat du consommateur. Pour ce faire le mareyeur procède à un mélange d'espèces entre petits pélagiques (sardinelles, chinchards, mulets), et espèces nobles (mérou, daurade, etc.). Toutes ces espèces n'ayant pas la même valeur commerciale, le consommateur peut ainsi faire son choix.

A Nouakchott, les prix de vente du poisson sont actuellement fixés comme suit:

mérou blanc, mérou bronzé	60 UM/kg
courbine, daurade, mulet	40 UM/kg
badèche ou faux mérou	35 UM/kg

Les sardinelles et les chinchards étant débarqués en grande quantité leurs prix sont libres. Dans certaines localités cependant ils sont homologués et varient entre 50 UM/kg et 70 UM/kg en fonction des espèces. L'exportation des produits artisanaux à partir de Nouakchott est très rare, mais en période de surproduction, un courant existe vers le Sénégal (voir tableau 2 et tableau 3 en annexe).

Le contrôle de qualité et l'inspection sont assurés par le Centre national de recherches océanographiques et de pêche de Nouadhibou qui a une cellule de contrôle sanitaire des produits de la mer à Nouakchott. Dans les autres localités, les expéditions faites à partir de Nouakchott sont contrôlées par le Service de l'élevage, qui assure l'inspection du produit à l'arrivée et au moment de la vente sur le marché.

Pour les poissonneries modernes existant à Nouakchott, l'inspection des produits se fait à la réception, donc la veille de la vente au soir. Elle a pour objet de contrôler la salubrité du produit, les normes de conservation à l'état frais (glace dans des caisses isothermes). Une deuxième inspection se fait le lendemain matin avant la vente, elle est suivie de la délivrance du certificat d'origine et de conditionnement. Une dernière inspection se fait à 17 h 30. S'il y a des invendus jugés encore frais et salubres, le poissonnier en fait des filets qu'il met dans des sachets en plastique pour congélation. Dans le cas contraire, le stock restant est vendu pour la transformation en sous-produit. Cette procédure a pour objet de renouveler quotidiennement les stocks, en respectant des règles d'hygiène et de salubrité.

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ANNEXE

Tableau 1

Production pêche artisanale à Nouakchott
de 1980 à 1983
(tonnes)

1980	1981	1982	1983
3 882	6 218	5 014	6 397

Tableau 2

Consommation du poisson frais en Mauritanie par
localité approvisionnée à partir de Nouakchott
de 1980 à 1983 (kilogramme)

Localité	1980	1981	1982	1983
Rosso	244 900	520 000	659 000	937 000
Boghé	153 000	310 000	425 500	616 000
Kaédi	112 500	270 000	327 500	711 000
Aleg	1 585	4 800	4 232	19 340
Ayoun El Atrouss	3 300	8 210	4 840	8 650
Kiffa	11 250	25 612	2 945	9 150
Nouakchott	3 355 332	5 012 837	3 161 080	3 550 081
Sélibaby	–	–	–	10 000
Diowol	–	–	1 000	18 000
Akjoujt	–	–	6 025	10 547
Bagoudine	–	–	–	8 000
Boutilimit	–	–	80	50
M'Bouth	–	–	–	400
Saint-Louis (Sénégal)	–	–	117 000	2 450
Darel Barka	–	–	1 400	–
Maghama	–	–	–	2 000
Tékané	–	–	4 950	4 000
M'Bagne	–	–	–	25 000
Bababe	–	–	–	13 000
Sous-produit	–	66 439	298 832	451 034
Totaux	3 882 000	6 218 000	5 014 384	6 395 702

Tableau 3

Consommation de poisson fermenté/séché par localité approvisionnée à partir de Nouakchott de 1980 à 1983
(kilogrammes)

Localité	1980	1981	1982	1983
Kaédi	1 400	1 388	3 300	2 140
Rosso	4 610	7 354	9 030	4 160
Boghé	12 865	24 394	10 850	3 216
Maghama	2 160	1 868	1 125	318
Ayoum El Atrouss	915	-	-	-
Sélibaby	2 600	8 194	12 790	818
Podor (Sénégal)	600	-	-	-
Nouakchott	26 000	29 634	-	19 839
Kiffa	-	102	-	228
Banabe	-	1 016	215	615
Likeseyba	-	110	1 470	928
Thies (Sénégal)	-	110	810	1 140
Saint-Louis (Sénégal)	-	-	7 820	5 436
M'Bouth	-	-	80	-
Sanghe	-	-	425	-
Tekané	-	-	64	-
Dakar (Sénégal)	-	-	1 350	1 480
Richard Toll (Sénégal)	-	-	890	1 610
Ourossogui	-	-	120	-
Ndoumaye Rewo	-	-	200	-
Totaux	50 700	74 170	50 539	41 928

FISH HANDLING AND DISTRIBUTION IN TANZANIA

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ABSTRACT

The paper describes the fish resources, fish handling on board vessels of different sizes, fish handling, marketing and distribution at the landing sites and at rural and urban markets. The trend of fish production is clear for the major fisheries. Transport of fresh and processed fish and price variations are discussed. Major constraints and recommendations regarding fish handling, distribution, marketing and the nutritional aspects of fish are given.

1. INTRODUCTION

Tanzania has an area of 940 000 km^2 with an area of 58 000 km^2 (6%) available for freshwater fishing. The population is approximately 20 million. Tanzania is mainly a pastoral and agricultural country.

Fisheries activities in Tanzania are under the Fisheries Division in the Ministry of Lands, Natural Resources and Tourism. From the latest statistics available (1983 Fisheries Division Annual Report) the number of fishermen was 32 400 with a total of 15 800 fishing vessels. The production was 272 500 t with an estimated value of T Sh 1 313 000. The freshwater fish production was 237 000 t accounting for more than 80% of the total catch.

Most of the fish is consumed locally. It is distributed and marketed fresh, smoked, sundried and a small amount is frozen. Small quantities of prawns are exported to earn foreign exchange.

The *per caput* fish consumption ranges from 1 kg to 50 kg near the coast and around the lakes. The average *per caput* is estimated at 12.5 kg (1977).

The fisheries policy aims at exploiting the resources to provide protein and obtain some foreign exchange.

2. RESOURCES

Tanzania is endowed with marine and freshwater fisheries.

2.1 Marine Fisheries

The territorial waters of the Indian Ocean extend to 50 n mi with a coastline of approximately 800 km with a narrow, steep coral continental shelf. The sustainable yield according to FAO (1984) is estimated to be 80 000 t. The present marine production is 35 000-50 000 t per year. This shows that there is room for expansion.

At river mouths there are prawns, mainly *Penaeus monodon*, *P. indicus* and *Metapenaeus monoceros*, which are very important on the export market. The important fishing grounds include Rufiji Delta, Mafia Channel and Pangani area.

2.2 Freshwater Fisheries

Freshwater fish production accounts for more than 80% of the total. It comes from Lake Victoria, Lake Nyasa, Lake Rukwa, Nyumba ya Mungu Dam, Kilombero swamps, Mtera Dam and minor waters.

2.2.1 Lake Victoria

Lake Victoria is a large, shallow lake (76 m deep and 5 730 km long). The fishery comprises the *Haplochromis* sp., *Protopterus aethiopicus*, *Tilapia* sp., *Bagrus docmac*, *Clarias mosambicus* engraulicypris and Lates niloticus. The current fish production is 50-60 t per year, while FAO (1984) estimates sustainable yield at 63 000 t. The appearance of the Nile perch (Lates niloticus) in the landings is very significant today. It is second to the Haplochromis in the trawls on the lake. It is a predator, feeding on the Haplochromis and other species.

2.2.2 Lake Tanganyika

Lake Tanganyika is 673 km long, 48 km wide and 1 470 m deep. Forty-one percent lies in Tanzania, 8% in Burundi, 45% in Zaire and 6% in Zambia. The fish production is 50 000-70 000 t per year. FAO (1984) estimates a sustainable yield at 100 000 t annually. The main species are Stolothrissa tanganica and Limnothrissa miodon. There is plenty of room for expansion.

2.2.3 Nyumba ya Mungu Dam

The catches of the Nyumba ya Mungu Dam are decreasing due to fishing pressure. The main species included Oreochromis pangani and O. jipe, but now O. esculentus is dominant.

2.2.4 Lake Nyasa

Little is known about Lake Nyasa. The fish production is about 40 t annually. The main species in the lake are Tilapia, Barillus, Bagrus, Clarias, Engraulicypris, Haplochromis and Barbus.

2.2.5 Mtera Dam

This is a new man-made lake. The catch is adding to the production. No estimates have been made, though the fish caught in the dam is found in markets of Dar es-Salaam, Iringa, Mbeya, Morogoro and Dodoma.

2.2.6 Pond and minor fishery

Tanzania practises fish farming. There are about 800 ponds in the country. The minor fishery includes small lakes, rivers, swamps and floods. The annual fish production from ponds and the minor fishery amounts to 70 000 t.

Fish production from 1972 to 1983 is shown in Appendix 1. The amount landed has increased from 160 000 t to 275 000 t. FAO (1984) gives an estimate of a total of 313 000 t per year not including the increasing Nile perch production in Lake Victoria. This suggests that the fish production in Tanzania can be increased by increasing the fishing effort both on the marine and on the freshwater fisheries.

3. FISH HANDLING ON BOARD VESSELS

3.1 Fish Handling on Vessels Below 10 m

3.1.1 Vessels

The majority are traditional vessels with LOA upward of 2 m. On average, the vessels are between 3 m and 5 m (LOA) with a draft of around 1.4 m and width of 1-1.5 m. This gives a small loading capacity. Normally the vessels can contain gear and catch, leaving space for fishermen. A few bigger vessels of 8-10 m have an ice box on board. On these bigger vessels, it is common to find baskets made from bamboo or strong leaves/stems.

In both marine and freshwater, very few fishing vessels are powered with engines. Sail is the most common propulsion method. Sails used are a Lateen type made of cotton material. Padding and poling are common in inshore waters along the coast and around the lakes.

3.1.2 Fishing

In general, fishing activities for these vessels fall within 5 km from the shore line. This includes marine and fresh water. The limit is due to the size and propulsion method of the vessels.

The common gear used are handlines, longlines, gillnets including shark nets in marine water, beach seines, small purse seines or liftnets (light fishing) and traps made from local material. At the moment, there is a shortage of gear supply, especially nylon products.

Fishing time depends on season and location. Generally, actual fishing with each gear is as indicated in Figure 1.

Gear	Day							Night					
	6	8	10	12	14	16	18	20	22	24	2	4	6
Handline	▨	▨	▨	▨	▨	▨							
Longline	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	
Gillnets and shortnets								▨	▨	▨	▨	▨	
Traps	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	
Beach seine	▨	▨	▨	▨	▨	▨	▨						
Purse seine/ liftnets								▨	▨	▨	▨	▨	

Figure 1 Actual fishing time with different gears

3.1.3 Fish handling

Catches in marine water vary with gear used, fishing ground, season and location. Mostly, catches from different gears contain different species and size. Only purse seines or liftnets in light fishing has consistant catches; more than 95% are mackerel and/or sardines, depending on season and fishing grounds. In fresh water, there is so little gear selectivity that it is not worth gear selectivity classification.

With the limited type of gear, most of the fish is taken on board fresh, if not alive. Deteriorated fish can only be found in catches from gillnets/shortnets and longlines, or sometimes in traps if left for a long period.

Handling practices on board traditional vessels are limited to sorting the catch.

In marine waters sorting is mainly based on cartilaginous fish and bony fish. These are placed separately in the bottom of the boat. The common sorting criterion is size - big and small. On certain occasions there are three groups - big, medium and small. On bigger vessels the sorted fish are placed in baskets. On vessels with an ice box, sorted fish are iced and separated by polythene sheets.

In fresh water, sorting is based mainly on species. Catches of the same species are sometimes sorted according to sizes.

Other handling practices, i.e., gutting, bleeding, are not practised on board. Although Fisheries personnel have been trying to convince local fishermen of the importance of gutting in increasing the keeping time of fresh fish, most customers will doubt the freshness of a gutted fish on the landing station. It has been a practice to gut/split a few spoiled fish on board the vessels, a preparation for sundrying for the use of the fisherman himself.

However, gutting on board for increasing the keeping time of fresh fish has to be given a second thought on these vessels. In the bottom of these vessels, due to waves and constant leakage between planks, there are a few litres of warm water. The water is mixed with dirt from the fish and the fisherman's legs, and it doubtless contains a lot of spoilage micro-organisms. Thus, if gutting has to be done on board and fish are stored in these conditions, it would mean an increase in microbial infection of the fish. Proper cleaning of gutted fish may not be possible on vessels of this size. Before the development of boat size, the only possible solution for increasing keeping time is to use the principle of cooling by evaporation. A small container which would cool whole fish by evaporation would be adequate.

3.2 Fish Handling on Vessels Above 10 m

3.2.1 Vessels

The largest fishing boat in this group is 30 m. Most of the fishing vessels are 10-15 m, with insulated fish holds and/or ice box on board. A few have refrigerated fish holds. The vessels carry fish boxes during fishing; the fish boxes are made from either wood, plastic or aluminium. Nearly all the vessels are propelled by inboard diesel engines.

Most of the vessels are owned by the Government or government parastatals. Table 1 shows the percentage of commercial boats and ownership in Appendix 2.

3.2.2 Fishing

Vessels in this group are designed either for trawling or purse seining. A few can operate both fishing gears. Trawling is normally done during the day and purse seining during the night using light fishing.

Fishing trips can last one day or several days before landing the catch. The time budget for one-day fishing is as in Figure 2 below.

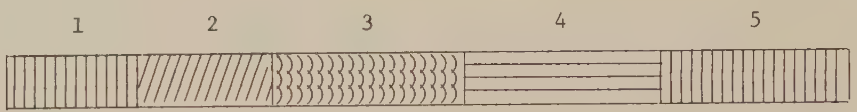

Figure 2 One-day fishing time budget

1 = Fishing preparation
2 = Steaming to the ground
3 = Fishing
4 = Steaming to the harbour
5 = Unloading the catch

The time budget for a longer fishing trip is indicated in Figure 3. Normally, the catch is stored on board until the end of the fishing trip (4-10 days). But sometimes, a fish-carrier vessel is used or, in some cases, fish are landed on a nearby landing place and transported to the marketing harbour by insulated truck or van.

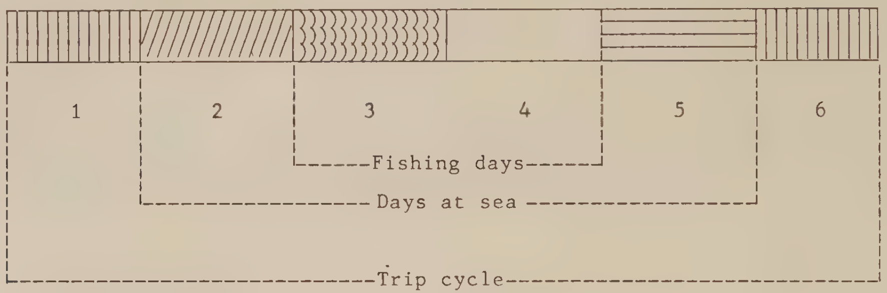

Figure 3 Several days fishing time budget

1 = Preparation for fishing off days
2 = Steaming to the ground
3 = Fishing time
4 = Resting time
5 = Steaming to the harbour
6 = Unloading the catch

Catches from trawlers are composed of many species. Most of the fish caught are small, as shown in Table 2 in Appendix 2. In purse seines using light fishing, marine catches are mainly composed of sardines and mackerel while in fresh water the main species Limnothrissa and Stolothrissa in Lake Tanganyika, and the Haplochromis in Lake Victoria.

Fish are brought on deck fresh. Sometimes, especially in trawls with big catches, fish suffer physical damage due to pressure.

Fish are sorted in sizes; large, medium and small, then are iced in boxes or containers and placed in the fish hold. Most of the vessels practise bulk icing in the fish hold. This is attributed to lack of containers.

Fish are not bled or gutted on board commercial vessels. Only government non-commercial vessels do gut fish on board. This is for training purposes.

4. FISH HANDLING AND DISTRIBUTION AT LANDING SITES

4.1 Urban Landing Sites

In the early 1970s, the Government established fish receiving stations (FRS) at the major landing ports. These stations were provided with port terminal facilities such as cold stores, ice plants, water, fish auction halls, weighing devices and recording facilities. These facilities were provided at Mwanza (on Lake Victoria), Lang'ata (on Nyumba ya Mungu Dam), Musoma, Bukoba (both on Lake Victoria), Kigoma (on Lake Tanganyika), Itungi (on Lake Nyasa) and Mikindani (on the coast).

At the same time, the Government established village fishing units (VFU) which were to function as fish receiving stations at a village level. They were provided at both the coastal and lake areas. They were provided at Nansio (on Lake Victoria), Mbangala (on Lake Rukwa), Nyamwembe (on Lake Victoria), Bagamoyo and Moa (on the coast).

The fish receiving stations and village fishing units have been plagued with constant breakdowns of the ice plants and cold stores due to lack of specialist technical know-how.

The National Cold Chain Operation (NCCO) has made use of the FRS and VFU and thus greatly facilitated the handling, distribution and marketing of fresh and frozen fish in urban centres such as Dar es-Salaam, Mwanza, Mbeya, Iringa, Morogoro, Arusha and Moshi.

However, in other towns the fish are landed at specific sites where the fish can easily be handled, distributed and marketed, for example, the Banda Beach in Dar es-Salaam.

Fish landed at the landing site is sorted by size, species and quality. It is placed in fish containers, weighed, recorded and auctioned. Gutting and washing may be done on some fish. Direct consumers and housewives like their fish to be descaled, gutted, washed and sliced or filleted at the station. Appendix 3 shows the distribution pattern at the landing site.

The fish from landing sites are placed in baskets ("tenga"), gunny bags, plastic and aluminium containers and taken on bicycles, pick-ups, buses, by hand, etc., to the home for consumption, to restaurants, hotels, to the central market and to the rural markets for resale.

4.2 Rural Landing Sites

The rural landing sites are not prepared specifically for fish landing. There are no port terminal facilities. There may be a fisheries field staff to take statistical records. The fish are placed on the ground and on the sand. They are sorted into size, species and quality. In a few places, the fish are placed on mats, on the grass and in locally-made containers.

Then the fish are auctioned or sold to consumers by the barter system.

Near the beach, the people prefer fresh fish and small catches are disposed of directly to consumers. When the catch is large, part of it is sold fresh at the site, part of it is taken to interior markets away from the land site. Then the surplus is scaled, gutted, washed and smoked for distant markets. Smoking is done for big fish while small fish are normally sundried for human consumption. The popular sundried fish are the "dagaa" - Stolothrissa tanganica, Limnothrissa miodon and Protopterus aethiopicus. The commonly smoked fish are the Tilapia sp., Bagrus docmac, Clarias mosambicus, Lates niloticus and Protopterus aethiopicus. The Haplochromis are smoked (barbecued) for human consumption while the bulk is sundried on rocks and on sand for animal feed.

The transportation of fresh fish is mainly done by NCCO in insulated trucks with ice. A few businessmen transport fish in insulated containers with ice. With use of ice the fish distribution radius is increasing with better fish quality.

Experiments on transporting iced fish were conducted at Nyegezi Fisheries Institute with success. An insulated truck with Allibert fish boxes was used.

5. FISH TRANSPORTATION AND DISTRIBUTION

The greatest part of fresh fish consumption is restricted mainly to areas lying within a short distance from the landing stations. The main obstacles to the distribution are the availability of transport and facilities. Sundried or smoked dried fish, especially from fresh water, are consumed all over the country. The main products are smoked tilapia from Nyumba ya Mungu Dam and Lake Rukwa na Mtera Dam, dried dagaa (Stolothrissa and Limnothrissa) from Lake Tanganyika, smoked Bagrus and Synodontis from Lake Victoria and Clarias from Kilombero River, Lake Rukwa and some other minor waters.

Frozen tilapia and Nile perch from Lake Victoria are airlifted to Dar es-Salaam, Arusha and Dodoma mainly by NCCO and a few private dealers. Iced tilapia from Nyumba ya Mungu Dam are transported by NCCO to Dar es-Salaam using insulated trucks.

5.1 Transport Means and Cost

5.1.1 Bicycle

Bicycles are the main means of transport for distribution to areas lying within a short distance from landing stations. Most are of the fishmongers' own bicycles and some cover a distance up to 20 km. Normally, fresh fish without ice are packed in a big basket and carried on the back seat of the bicycle. One bicycle can carry between 40 kg and 60 kg distributing sales to market places or door-to-door sales.

5.1.2 Pick-ups and lorries

Uninsulated pick-ups and lorries distribute fresh fish up to a distance of 60 km from the landing harbour. The price is negotiable. It ranges from T Sh 2 to T Sh 10 per kilogramme, depending on location, availability of transport and distance to the market place. Fish are packed in big baskets which can each take 50-75 kg. The baskets are piled up in vehicles and ice is rarely used.

Most of the processed fish are distributed by lorries. Fishmongers share the hiring of lorry to transport fish from the landing sites to urban areas. The distance covered is up to 600 km.

5.1.3 Railways

Only Tazara Railway (Dar es-Salaam to Mbeya) has insulated wagons to transport fresh fish. On the other railways fishmongers usually hire a wagon for distribution of processed fish. The maximum distance covered is about 1 200 km and the cost is about T Sh 150-200/kg of processed fish. For Dar es-Salaam-Mbeya, which is about 1 000 km, transport of fresh fish costs about T Sh 3.50-4.50/kg (including the ice).

5.1.4 Air

Air freight has been a common way of distributing frozen tilapia, Nile perch and fillets of *Bagrus*, *Clarias* and *Protopterus* from Mwanza to Dar es-Salaam and Arusha. The total charges are about T Sh 6.40/kg Mwanza-Dar es-Salaam; Mwanza-Arusha is T Sh 5.60/kg. In both cases a waybill per consignment of T Sh 30 is added.

Air freighting of marine species to Dodoma is increasing. This costs about T Sh 5.60/kg plus the waybill per consignment.

5.2 Price Distribution

Price is a function of supply and demand. Due to lack of fishing gears and means of distribution it can be concluded that demand of fish in Tanzania is much higher than the supply. Prices vary with season, availability of fish and location. It is almost impossible to get the actual price distribution in Tanzania at the moment. Table 3 in Appendix 2 shows a rough price distribution of different species in different towns.

5.3 Facilities and Equipment

Transport of iced fish is done by using the bulk-icing method. In a few cases wooden boxes, which can each hold 30-40 kg, are used.

Frozen fish are transported in hard paper cartons, each carton containing about 40-50 kg of fish.

As mentioned in 5.1, processed fish are transported in big baskets made from local material. The shape of baskets varies with the area. These baskets are made to be strong. Dry grass is used for absorbing shock.

6. CONSTRAINTS AND RECOMMENDATIONS

Although fish handling and distribution is improving, there are still problems facing fish technology development in Tanzania.

(1) In order to develop the technology, fish must be available for handling, processing and distribution. The number of fishermen is decreasing because of an acute shortage of gear (See Appendix 1).

The resources show that there is room for expansion. More fish can be harvested, up to 313 000 t without adversely affecting the stocks. This calls for a closer look into the fishing gear production by the National Fish-nets manufacturers and the supply to the fishermen. Instead of selling fishing gear outside to get foreign currency, fish could be exported to earn the foreign exchange and, at the same time, provide employment for the people.

(2) Related to this problem is the unavailability of marine engines and spare parts. This problem has confined marine fishing to near the shore.

By using powered boats more fish can be landed with better quality.

(3) Technological aspects such as post-harvest losses and lack of quality control. A good amount of fish goes to waste due to spoilage.

There is a need to improve the organizational aspects of manpower development and training. Training should be directed to problem solving.

(4) Transport aspects. The bad roads cause vehicles to suffer very fast wear and tear. Hence, transport of fish from one area to another is extremely difficult. The frequent breakdowns result in a lot of waste. This is a national problem which requires careful planning and economic resources. However, improvement of packing would reduce waste during transport.

(5) Utilization aspects. Fish is a good source of protein. Its direct substitutes are meats and beans. The price of fish is very high bearing in mind the food value. Since the demand is higher than the supply, then the question of price cannot be solved. The real answer is to produce more. At the same time, the people should be educated to realize the nutritional aspects of fish and its substitutes.

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APPENDIX 1

Fishing Effort and Production in Tanzania

Year	Number of fisher-men	Number of vessels	Type of fishing gears					Fish production			
								Marine			
			Gillnets	Seines	Hooks	Total weight (t)	Pro-duction value	Weight (t)	Value ('000 T Sh)	Fresh weight (t)	Water value ('000 T Sh)
1972	44 013	17 991	192 937	9 297	477 098	163 912	154 061.9	28 679	46 886.6	135 233	107 175.3
1973	47 516	20 162	213 178	2 390	179 618	164 702	186 480.6	26 342	50 737.5	138 360	135 743.1
1974	42 466	37 064	26 113	2 129	182 319	163 619	247 638.8	25 895	70 290.4	147 710	177 348.4
1975	45 348	39 922	181 634	9 290	470 768	192 398	327 591.6	32 031	99 778.5	160 367	227 813.1
1976	61 108	27 045	264 274	2 522^{F}	101 248	240 753	543 202.2	49 969	202 466.2	190 784	340 736.0
1977	45 999	19 645	180 446	2 595	289 761	26 302	714 594.8	46 995	265 462.4	214 307	449.132.4
1978	42 702	16 281	103 312	1 417	292 059	211 098	627 413.8	47 323	267 151.2	163 775	360 262.6
1979	60 554	22 557	128 870	4 158	383 841	180 559	477 050.7	33 816	122 466.6	146 743	354 584.1
1980	46 417	19 698	147 890	1 335	165 855	231 741	1 232 928.0	39 276	230 412.3	191 465	1 002 515.7
1981	47 190	19 701	143 510	3 007^{m}	235 270^{R}	231 336	1 029 030.0	39 576	276 410.0	191 760	752 620.0
1982	38 379	12 135	140 403	-	270 438	224 410	1 769 939.2	23 669	455 032.7	200 741	1 314 906.5
1983	32 323	15 800	-	-	-	272 498	1 167 490.2	35 518	382 500.0	236 980	930 510.0
Average	46 168	22 333	178 688	3 814	277 117	192 248	536 805.0	35 757	205 799.6	176 519	512 777

Value of fish has been estimated from the prevailing beach price

APPENDIX 2

Table 1

Percentage of commercial boats and ownership

Fisheries	Commercial (Government)	Non-Commercial (Government)	Commercial (private)
Marine	46.5	2.3	9.3
Freshwater	16.3	11.6	14.0
Total	62.8	13.9	23.3

Table 2

Size distribution of catches (%)

Fishing method		10 cm	10-30 cm	30 cm
Trawling	Marine	70	20	10
	Freshwater	85	10	5
Purse seining	Marine	60	39	1
	Freshwater	90	8	2

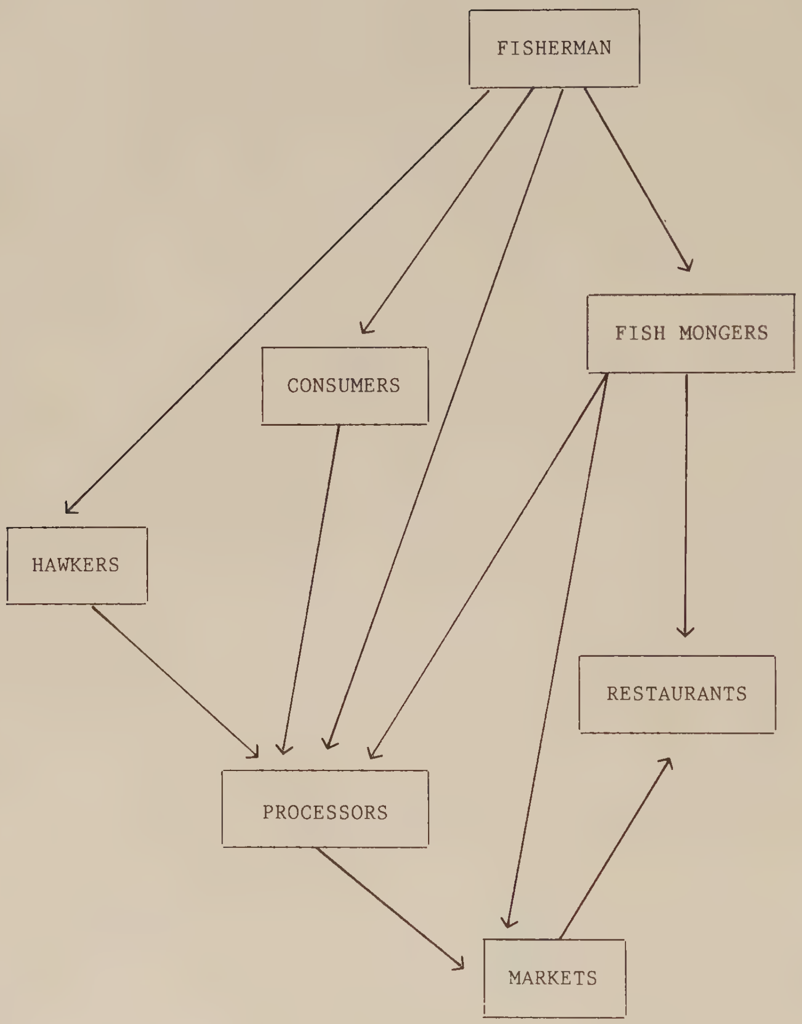
Table 3

Price per kilogramme in Tanzanian shillings

Source	Species	Price at				
		Landing site	DSM	Dodoma	Arusha	Mbeya
Lake Victoria frozen fish	Nile perch Tilapia	15.00	55.00	65.0	55.00	60.00
Lake Tanganyika dried fish	Dagaa	24.00	85.0	75.00	60.00	110.00
Nyumba ya Mungu Dam smoked fish	Tilapia	4.50	60.00	50.00	25.00	70.00

APPENDIX 3

Fish Distribution in Tanzania at the Landing Site


FISHERMAN
FISH MONGERS
CONSUMERS
HAWKERS
RESTAURANTS
PROCESSORS
MARKETS

INSULATED CONTAINERS FOR HANDLING OF FISH ON BOARD PIROGUES IN SENEGAL

by

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ABSTRACT

Handling of fish on board pirogues still requires a substantial improvement to maintain a good quality of fish. The insulated containers which allow to store the ice and later fish in ice on board pirogues going out for 3-5 days fishing trip in Senegal have been designed, constructed and tested with very good results. Ten containers of about 1.3 t of fish capacity have been made. This paper provides background information on the construction, material required and cost involved.

1. INTRODUCTION

Handling of fish on board pirogues seldom received attention mainly due to the fact that rarely trips are short, seldom exceeding one day. However, it has to be kept in mind that spoilage begins since the fish is dead and even a few hours in tropical ambient temperature can cause a significant degree of spoilage which, due to further improper handling ashore, leads to poor quality of fish on the market.

Very particular situation exists in Senegal where sufficiently large pirogues called "icing pirogues" (pirogue glacier) are off for 3-5 days to fish with handlines for highly priced bottom species. Pirogues even if called "icing pirogues" seldom take ice to the sea due to the lack of proper storage facilities, the ice melts out quickly providing only marginal protection for fish.

Efforts have been made by local fishermen to construct a compartment or even a container to keep ice and fish in ice but results were not very encouraging. Plywood or corrugated steel sheets did not provide sufficient insulation and ice was still melting too fast.

To improve the existing situation, FAO decided to assist fishermen in the construction of properly designed containers made from materials locally available. Ten such containers have been constructed and presently are under extended trails which will last for about one year (till late 1984). However, information already available confirmed full usefulness of the containers and their economic viability.

At least 200 such containers are required for Senegal and further work should be aimed toward adaptation of the containers for very large pirogues fishing for sardinella and other pelagic species.

2. WHY DO WE NEED INSULATED CONTAINERS?

It should be a main goal for fishermen to bring ashore a fish of the best possible quality. On larger boats with chilling facilities on board this is not a great problem, but it is not always easy to assure that fish brought by artisanal fishermen is equally good. Chilling fish with ice seems, however, to be the only solution, particularly if fishing grounds are a few hours away from the landing centre.

Chilling reduces the activity of bacterias and enzymes and retards the spoilage. Spoilage is not a reversible process and therefore it is important to retard it from the very beginning. Rate of spoilage depends on the temperature, time, as well as species of fish. This is illustrated in Figure 1.

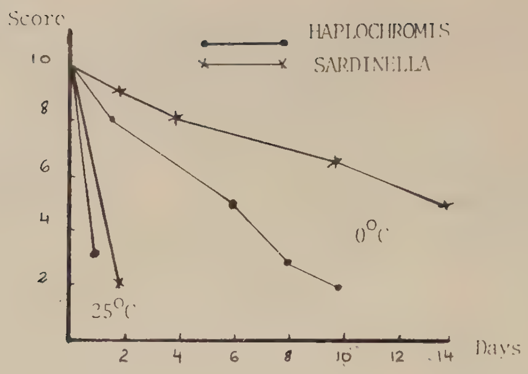

Figure 1 Spoilage rate of sardinella (S. aurita) and Haplochromis sp. at 25°C (A), and 0°C (B) (after Mlay et al., 1982)

Data provided in Figure 1 indicate that fish kept in temperature of 25°C become spoiled in less than two days, kept in ice they will remain in good condition for a week and even longer.

Ice is a good mean for cooling fish as it has a large cooling capacity for a given volume. Crushed ice is better than block ice, as it enables the fish to be surrounded by small pieces and thus cool rapidly. This is achieved by the heat from the warm fish flowing to the cold ice removing the heat of the fish and melting the ice.

Should the iced fish be stored in a simple wooden or plastic box melting of the ice will be accelerated by the proximity of the surrounding air with its higher temperature. The ice tries to chill everything in its immediate vicinity by conduction (transfer through the structure of the box material), diffusion (heat loss by evaporation), convection (heat loss by passage of air over cooled surfaces).

The introduction of plastic boxes in the industrial fishery where they are used in insulated or chilled stores was a significant step forward in improving of handling practices, however, the plastic boxes cannot be recommended for artisanal fisheries due to high melting rate of ice (see Table 1).

Table 1

Average melting rates during storage of block ice
(Average ambient temperature 28.2°C)

Average melting rates during storage of block ice			
	% melted after 12 h	% melted after 24 h	% melted after 48 h
Insulated container	7	12	23
Ice covered with sawdust	11	22	45
Uninsulated plastic box	53	90	-

(after Villadsen, 1979)

As it can be seen in uninsulated plastic box, 53% of ice was melted after 12 h and 90% after 24 h. Though in insulated container (5-cm polystyrene foam) melting loss was only 12% after 24 h and 23% after 48 h. It could be deducted therefore, that use of insulated containers significantly reduce losses of ice and help to maintain a low temperature thus extending the storage life of fish allowing for longer fishing trip or holding the fish during glut period when prices are low.

3. CONSTRUCTION OF THE CONTAINERS

3.1 Basic Data about Containers

The principles of the containers described in this paper are as follows:

- 10 cm of high density polyuretane foam covered with one layer of resin, reach 450 g/m^2 fibreglass mat forming the container walls and structure;
- insulated waterproof hatches;
- protection of exposed areas and decking to give further protection and shade;
- containers are roughly fitted into the shape of 14-18 m long pirogues;
- capacity of the container are about 0.9-1.3 t of fish;
- approximate weight of the container is: 200 kg (for two hatches) and 270 kg (for three hatch-versions);
- containers are not permanently fixed into canoe and can be easily removed.

The diagrams of two hatch-containers and a picture of a larger one with three hatches are given on Figures 2 and 3.

The construction of insulated containers needs the supervision of a person who has previous practical experience of fibreglass materials as care and training in their use is necessary to achieve a satisfactory result and to ensure the safety of the persons handling the raw materials.

Such a person may have attended an FRP course at some time; be working in a boatyard or a factory producing FRP items such as car body panels or bathroom and toilet furniture or be an extension specialist already maintaining and repairing FRP boats. Once this key person is available, a carpenter and a helper would complete the team necessary to make a container in about one working week.

The place to construct this need not be big, but a local boatyard would be the first place to try on the basis of experience and equipment. If this is not possible then any shaded, dry, clean and well ventilated area will do; shaded to prevent the sun's heat prematurely curing the resin; dry, as moisture can spoil a resin mix; clean, as dirty or oily conditions can contaminate the chemical reaction in the resin curing process; and well ventilated to ensure a supply of fresh air to the workers in order not to inhale fumes given off by the chemicals.

3.2 Materials Required

The materials that will be required to use will be primarily:

- polyester resin;
- glassfibre mat and cloth;
- peroxide catalyst;
- cobalt accelerator;
- acetone;
- polyuretane foam;
- hardwood;
- playwood.

Detailed breakdown of the cost and material required are given in Table 2.

3.3 Tools Required

The following tools are required in the making of the insulated on-board fish containers (Figure 4): grinder, hammer, wood saw, old saw blades for scraping, tape measure, marking pen, stanley knife, paint brushes, plain wood 8 cm, laminating roller, omo-abrasive soap for hand cleaning, measuring tube for catalyst, square, hole saw, mixing/cleaning bucket.

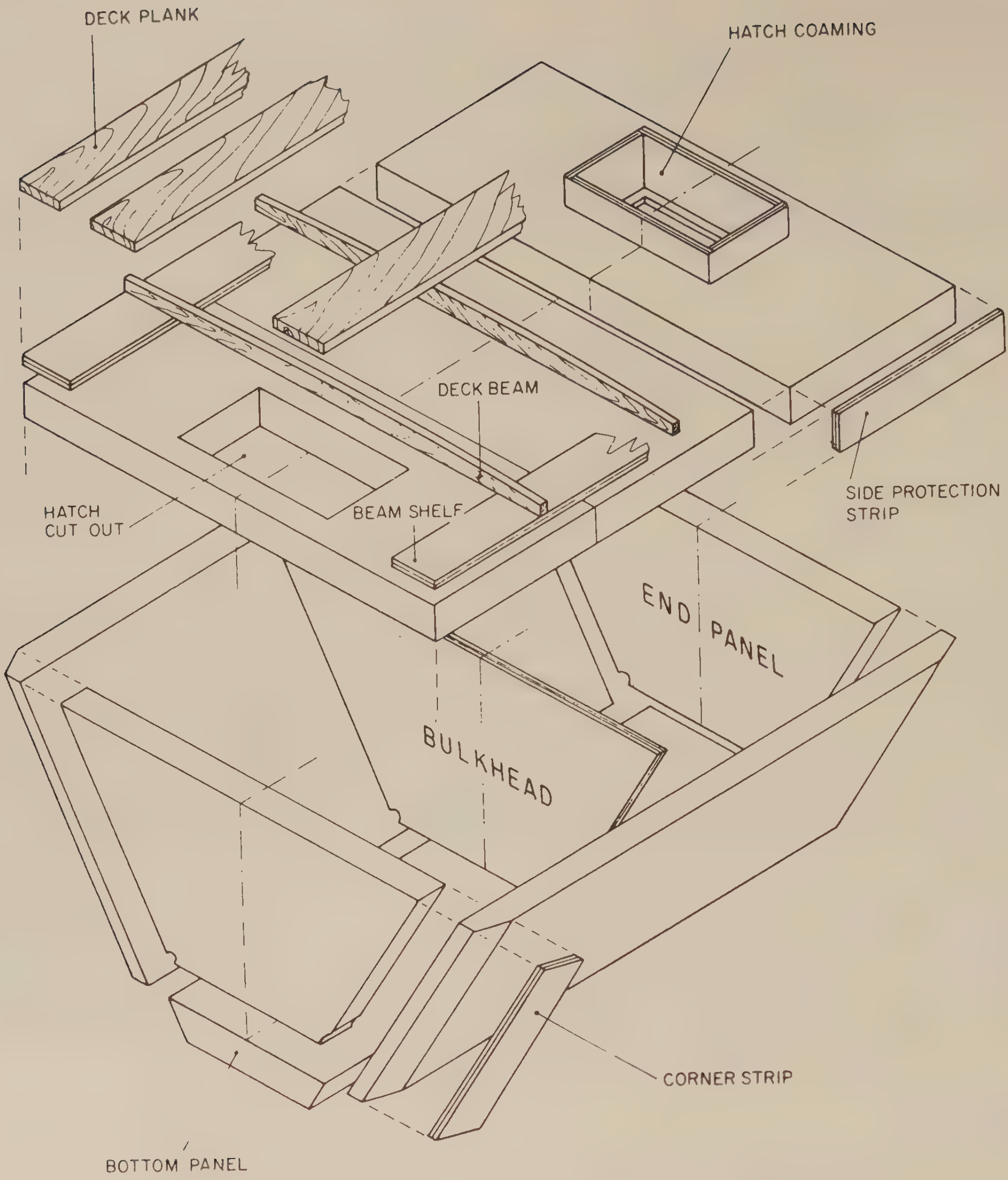
DECK PLANK
HATCH COAMING
DECK BEAM
HATCH CUT OUT
BEAM SHELF
SIDE PROTECTION STRIP
END PANEL
BULKHEAD
CORNER STRIP
BOTTOM PANEL

Figure 2 Sketch diagram of two hatch-containers

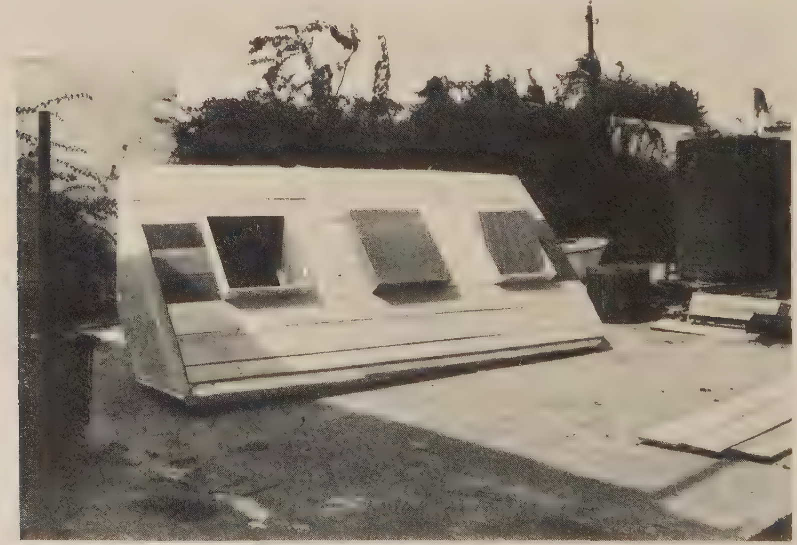

Figure 3 Three-hatch-container

Table 2

Breakdown of the material required and the cost[a] for construction of small and large on-board container

Material	Unit Price	Two hatch-container	CFAF	Three hatch-container	CFAF
Foam sheet 1.9x0.1x0.9	15 000 HT	8.5	127 500	11	165 000
Rasin/kg	825 HT	75	61 875	100 kg	82 500
Mat 450 gr/m^2	800 HT	34 m^2	27 200	45 m^2	36 000
PVC Tube/m	800 HT	0.6	480	0.6 m	480
12 mm Ply/sheet	7 227 HT	3	21 681	4	28 900
18 mm Ply/sheet	11 000 HT	2	22 000	3	33 000
Screw each	25 TT	25	500	20	500
Nails/kg	500 TT	2 kg	1 000	3 kg	1 500
Bois rouge/m^3	96 792 TT	15mx0.23x0.002	6 679	24mx0.23x0.02	10 686
Paint/Lt	2 500 TT	3Lt	7 500	3Lt	7 500
Rope/m	250 TT	1m	250	1m	250
Bois blanc/m^3	63 375 TT	35x0.23x0.02	10 203	40x0.23x0.02	11 661
TOTAL			286 868		377 977

[a] Material cost as for 1 January 1984 - US$ 1 = CFAF 360 HT = VAT and duty free, TT = items tax paid

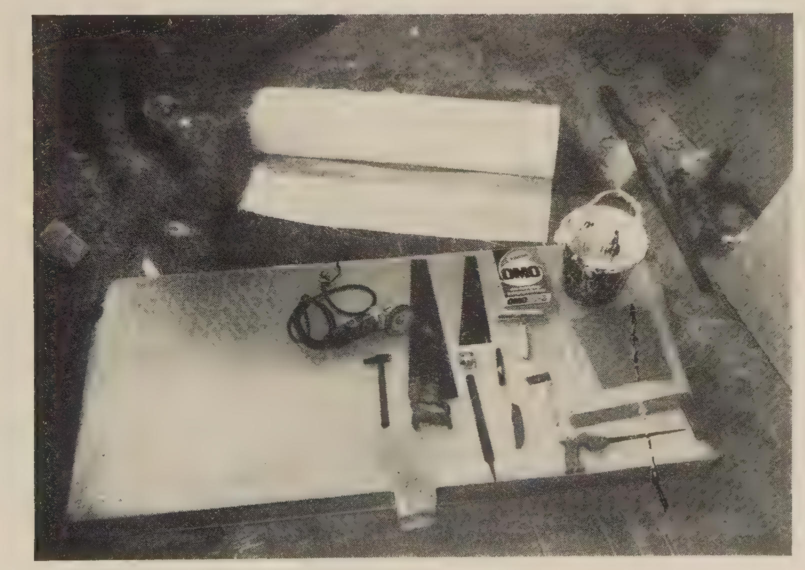

Figure 4 Tools used in the market of insulated fish containers

As it can be seen only simple woodworking tools are necessary but if a circular saw is available to cut out straight, well-fitting edges to the foam sheets and a powered grinder to smooth off any hard resin drips or rough corners then the task will be easier. Details of construction and how to make the containers can be found in FAO Fisheries Circular No. 775.

4. EVALUATION OF THE CONTAINERS

Though durability with on-board containers will be going on for a longer period, information from exploitation of the first two containers is already available and very encouraging. Table 3 provides summarized data on exploitation of three pirogues during a three-month period which corresponds to 15 trips.

Table 3

Comparative results on use of on-board insulated fish containers

	Container 1 FAO	Container 2 FAO	Traditional container
No. of fishermen	6	6	8
Duration of trip	5	5	3
Ice (kg)	750	675	1 200
Petrol (litres)	110	100	130
Quantity of fish caught (kg)	1 226	1 253	1 017
Ambient temperature	27°-28°C	27°-28°C	27°-28°C
Quality of fish			
- 1st quality	69%	75%	8%
- 2nd quality	30%	25%	12%
- 3rd quality	1%	-	31%
- 4th quality	-	-	20%
- 5th quality	-	-	2%
Rejected	-	-	27%
Marketing value of the catch	CFAF 198 130	CFAF 181 130	CFAF 83 410

Note: data in the table represent the average per trip calculated on 15 trips

(From: Rapport d'évaluation de la phase I, Projet: Amélioration de la conservation de poisson à bord des pirogues, CAPAS, Senegal 1983).

As it clearly can be seen, use of insulated containers allow to extend the average trip from 3 to 5 days, bring more fish, use less ice and petrol and bring a top quality fish which pays well.

Seeing the difference in value of the fish from one trip and assuming the price of the container about CFAF 350 000 it can be said that the whole investment is paid back in four trips which is above the expectations of all involved and without exaggeration one can say for sure that construction and proper use of the insulated containers is a good and quickly paying back investment.

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A NOTE ON THE IMPROVEMENT OF ONSHORE FISH HANDLING AND DISTRIBUTION IN SENEGAL

by

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ABSTRACT

The paper provides the preliminary results of the experimental use of small insulated containers (70 l and 200 l capacity) for distribution and marketing of fresh fish in Senegal.

The quality of fish from the containers was significantly higher than that from traditional baskets. However, the price difference paid at the market provides a rather small profit margin when using the containers. The situation may be different in case of distribution and marketing of fish into distant, inland markets. Study in this respect has not been completed yet.

1. INTRODUCTION

Approximately 160 000 t of fish are annually landed by artisanal marine fishermen in Senegal. This represents roughly 60 % of the national landings. Growth recorded during the seventies is largely attributable to the introduction of major technological innovations: motorization of the pirogues and purse seiners.

There has been no corresponding improvement in the marketing sector, which however, could satisfactorily absorb the larger numbers of fish landed. At the present stage of development of small-scale fisheries in Senegal, any rise in productivity will be partly absorbed by export and partly lost due to fish thrown back at sea or poor fish handling and distribution for the inland markets.

The project launched by FAO proposes to improve fish quality by improving handling from catch to consumer using small insulated containers. The project is in line with integrated approach to development of small-scale fisheries in Senegal viewed as a system.

CAPAS (Centre d'aide à la pêche artisanale sénégalaise) is in charge of the first part of the project dealing with handling of fish on board canoes. The part of the project dealing with onshore handling and distribution is the responsibility of CRODT (Centre de Recherches Oceanographiques de Dakar, Thiaroye).

This paper provides some preliminary results on handling and distribution of fish in the insulated containers into close markets.

2. PRESENT GAPS IN HANDLING AND PRESERVATION OF FISH LANDED BY ARTISANAL FISHERIES

Roughly 85 000 of the 160 000 t of fish landed by artisanal fisheries in Senegal are intended for direct consumption.

Once the demersal fish, usually caught with a line or set net, have been landed they are laid out on the beach, on the sand, to await prospective buyers. After being in the bottom of the canoe for several hours, they are then contaminated by sand often polluted by wastes from homes and cottage industries.

Purchased fish are carried in baskets to the processing area or the place where the fishmongers have parked their vehicles. The "parking areas" they use are often unpaved areas with big puddles formed by the melting ice, and great ruts. Before the fish is loaded on the vehicles, it is again laid on the ground or on a tarp. Next, it is packed in baskets with flaked ice. Two possible sources of contamination at this phase of the process should be mentioned:

- The mud-covered parking areas are a real culture medium, and swarming with insect larvae.
- The ice used to preserve the fish has not been properly stored (it is merely covered with sawdust or groundnut shells).

The baskets are then loaded on non-insulated vehicles and dispatched to markets. This trip varies from 1-2 hours from the landing areas in the Thiès and Dakar region up to 12 hours for the most remote markets in the Senegal River area.

The ice/fish ratio varies greatly with the time of year. It may be 1 kg ice/1 kg fish during the cool period or more than 1 kg of ice in the hot season. On longer trips, such as Mbour to Matam, additional ice is added to the fish when they are loaded on smaller vehicles to facilitate distribution to the smaller inland markets.

Both transport time and the wait for the wholesale market to open at 5 or 6 a.m. must be counted. The fish are then sold individually or in batches to retailers or semi-wholesalers (on major markets). The fish is then sold to the consumer; small fish whole and large fish in pieces. The fish is displayed on wooden blocks or simply on a piece of oilcloth on the ground. These markets hardly ever have running water to wash the fish properly before sale.

If the fish does not sell well, the retailers and semi-wholesalers use poorly insulated "ice boxes" where the fish can be stored for some days on ice.

The pattern is pretty much the same for small pelagic species like sardinella, bonga or horse mackerel:

- the fish is often sold right off the canoe, which cuts down waiting time on the beach;
- however, it is often loaded in bulk onto vehicles, which hastens spoilage.

The brief description of current fish handling practices indicates a real possibility of technical improvements for canoes, landing places and markets. Fish quality would be markedly improved by the use of insulated containers. It remains to be seen whether this will be economically feasible given the socio-economic constraints of the small-scale fisheries sector.

3. USE OF INSULATED CONTAINERS FOR MARKETING FISH FROM LANDING AREAS TO "LA GUEULE TAPEE" MARKET IN DAKAR

3.1 Methodology

During the first phase of the project, FAO supplied sixty-five 70-litre containers and twenty 200-litre containers to CRODT. The experiments involved two fishmongers from Mbour and Kayar who regularly supply the market of la Gueule Tapée. These fishmongers purchased the fish on the beach and sold it on the market.

The containers were handed over to the fishmongers for the experiment: twelve 70-litre containers to the Mbour fishmongers and ten 70-litre containers and three 200-litre containers to the Kayar fishmongers. The fishmongers also continued to use their usual baskets, making it easier to compare the two methods.

The fishmongers were followed-up at the fish departure and arrival points.

The following data was collected at the purchase area:

- species purchased and the purchase value for each container;
- time gap between purchase and icing of fish;
- original quality of fish which was estimated organoleptically by the ITA (Institut de technologie alimentaire);
- quantity of ice in each container.

Data collected in the market concerned:

- sale price for each container;
- storage time of each container;
- amount of ice added;

- organoleptic quality of fish sold
- the fishmongers comments on the containers.

Our picture of how the containers work within the traditional marketing pattern was formed by direct observation at purchase and sale points.

3.2 Findings

3.2.1 Technical findings

Institut de technologie alimentaire (ITA) did the organoleptic analysis of the fish with our Mbour-based investigator over a two-week period. Tables were prepared to rank the organoleptic qualities of the major species landed so as to assess fish quality at purchase and at sale. Follow-up of the containers in Mbour lasted from 24/08/83 to 26/09/83 and from 27/10/83 to 16/01/84, a total of 39 observations. Follow-up of operations in Kayar was hindered by problems connected with the onset of the fishing season and we have only three observations.

3.2.2 General remarks

The fishmongers commented on container sturdiness, handling and vehicle loading properties.

- The containers were very sturdy, with a probable working life of three years under the conditions in which these fishmongers work. But their design makes them hard to handle (they are hard to carry on the head because of their weight - 12 kg -, they lack handles, and they are the wrong shape). The lack of handles is also a constraint in loading and lining up the containers in vehicles.

- They also emphasized the fact that buyers, who are used to purchasing 30 kg basket without weighing it, questioned the amount of fish in the containers, at least at the beginning of the trial period.

Originally planned for storing fish in CSW, this use of the containers proved impossible for two reasons:

(i) the seawater available at landing points was heavily polluted by cottage industries and home wastes, and was therefore unacceptable;

(ii) the use of chilled seawater would limit carrying capacity of the containers and cut down profit margin.

The fish sellers pack 30 kg of fish in the containers, i.e. the same amount as in the baskets. For an identical capacity, the containers have an external volume of 131 litres (external dimensions: 61 x 40 x 54 cm) and the baskets an 80 litres (diameter: 60 cm, height: 28 cm). Though baskets and containers can hold the same amount of fish, the containers use only 63% of the loading capacity as compared to the baskets. The transport gap mentioned by the fishmongers is even greater, as they say they can transport 150 baskets in a 5-ton vehicle but only 70 containers.

In terms of maximum use of the available transport space, the utilization of containers therefore, involves a clear lack of gain. Given the difference between the internal volume and the external volume of a container (61 litres) this lack of gain can be estimated at 75% of the capacity of one basket or 22 kg of fish.

3.2.3 Impact on fish quality

The fish sellers use flaked ice to preserve fish in the containers. Holes were punched in the bottoms of the containers to let the melt water drain off.

During the test period the fishmongers made their purchases in the morning (from 9 to 12 a.m.) and in the afternoon (between 2 and 8 p.m.). It takes about 15 to 20 minutes to pack the fish in the containers. The fish is kept until the following day and then sold on the market between 6 and 7.30 a.m., meaning that it is kept from 10 to 18 hours only. This is because the la Gueule Tapée market is so close.

The quality of the fish kept in containers was clearly better than that in baskets.

3.3 Economic Feasibility

3.3.1 Impact on fish sellers' gross margins

By gross margin is meant the difference between the wholesale market price and the purchase price on the beach.

In the la Gueule Tapée market, the price for fish in containers was a bit higher than that for fish in baskets (see Table 1). The average difference observed for round sardinella was 17 CFA francs per kilogramme. If the containers are to be worthwhile to these fish sellers the price difference will have to cover all extra costs involved.

3.3.2 Impact on costs

3.3.2.1 Labour costs

Use of the containers entails no extra work handling the fish on the beach or in the markets. Fish purchase and sale operations are the same with containers as with baskets.

3.3.2.2 Ice costs

Some savings on ice are possible with insulated containers. The ice: fish ratio drops from 0.6 to 0.5, i.e. 5 kg of ice for 10 kg of fish, representing a savings of roughly 54 francs per container utilized. The savings may be significantly higher for fish sellers supplying remote inland markets as they need to use much more ice.

3.3.2.3 Transport costs

The use of containers has no direct effect on the total cost of transport. However, the unused extra volume does mean that the average transport cost per kg of fish is higher.

3.3.2.4 Depreciation

The price of the containers (US$ 80 FOB) is high and corresponds to a local price of roughly 76 000 francs. Under actual conditions of use, it would seem that three years is a reasonable estimate of their working life. If a fish seller with a 5-ton vehicle buys 70 containers, the annual depreciation would total 1 773 333 francs.

The baskets presently in use are replaced every 7 days. One lot of baskets costs 45 000 francs, which amounts to a total depreciation of 1 285 714 francs based on a number of 200 working days per year.

In the light of these figures introduction of insulated containers would involve increased depreciation costs of roughly 497 619 francs per year.

3.3.2.5 Net impact of the use of insulated containers on the marketing cost

The trip from Mbour to la Gueule Tapée will be used as an example. The costs should be compared for 70 insulated containers and for baskets, as a 5-ton truck was used in both cases, the usual vehicle for this purpose.

Due to loss of working volume with containers, the amount of fish actually shipped was as follows:

- with containers: 2 100 kg
- with baskets: 3 640 kg

Those costs not affected by the use of containers (vehicle depreciation, insurance, taxes, labour) have been assessed on the basis of a survey carried out in 1981 (Chaboud, 1983) with the figures brought up to date at an annual rate of 10 %.

3.3.3 Impact on net margin

As the average difference observed for gross margin was 17 francs/kg, and the difference in marketing costs was 11 francs/kg, the use of insulated containers amounts to a net gain of 6 francs/kg, for the trip in question.

4. CONCLUSION

The fact that the containers are not adapted to real fish marketing conditions in Senegal means that certain modifications will be necessary before plans are made to distribute more of them. This would involve:

- adapting the container shape to handling, carrying and storing in the vehicle;
- fitting the containers with handles;
- providing a closable runoff system for meltwater.

Table 1

Comparative results

The utilization of insulated containers and baskets
by fish sellers

(values expressed in CFAF/kg of round sardinella)

Observations		Purchase price	Fish in Containers		Fish in Baskets	
Number	Dates		Sale Price	Gross margin	Sale price	Gross margin
1	25.08.83	50	83	33	65	15
2	26.08.83	25	83	58	65	40
3	27.08.83	47	89	42	87	41
4	28.08.83	30	133	83	121	71
5	31.08.83	50	117	67	110	60
6	01.09.83	50	94	44	53	3
7	02.09.83	50	97	47	83	33
8	14.09.83	42	117	75	90	48
9	15.09.83	13	97	84	60	47
10	22.09.83	58	133	75	94	36
11	23.09.83	67	150	83	121	54
12	24.09.83	50	127	77	114	64
13	25.09.83	25	83	58	81	56
14	27.09.83	33	30	17	50	17
15	28.09.83	58	117	58	83	25
16	29.09.83	50	125	75	117	67
17	30.09.83	33	110	77	100	67
18	06.11.83	33	83	30	83	50
19	12.11.83	20	107	87	104	84
20	14.11.83	33	109	76	91	58
21	16.11.83	50	133	83	114	64
22	17.11.83	35	67	32	61	26
23	18.11.83	50	83	33	64	14
24	19.11.83	50	57	7	40	-10
25	28.11.83	17	71	54	56	39
26	30.11.83	25	63	38	58	33
27	01.12.83	33	69	36	49	16
28	08.12.83	50	67	17	50	0
29	09.12.83	67	83	16	77	10
30	10.12.83	17	58	41	55	38
31	11.12.83	58	133	75	117	59
32	16.12.83	43	100	57	90	47
33	17.12.83	83	144	61	117	34
Average		44	99	55	82	38

Table 2

Comparative marketing costs on the Mbour -
La Gueule Tapée run (in francs/kg)

	Baskets	Containers
Quantity of Fish (kg)	3460	2100
Depreciation: baskets or containers	6428	8666
Ice	30576	14700
Other costs unaffected by type of packing	50300	50300
Total per trip	87305	73666
Average cost per kg	23.98	35.07

The small profit margin provides relatively little incentive for these fish sellers who have an empirical, fairly hazy assessment of their net income. The major initial investment represented by the purchase of the containers, compared to the cost of continually replacing the baskets, which is spread over a long period of time, would represent a heavy burden for these fish sellers who have very limited access to credit. These constraints might be dealt with in a number of ways:

- make it possible for the fish sellers to import the equipment duty-free;
- make it possible for them to get soft loans from financing agencies;
- consider producing the containers locally.

The latest would depend on whether there will be a sufficiently large market to make economies of realistic scale. A 1982 survey by CRODT of fishmongers and their means of transport estimates the total number of fish sellers at 100 and the total transport capacity of the sector at 370 tons. If all the fish sellers were to buy the containers, this would probably involve a roughly total of 5 500 containers. A major potential market for the 200-litre containers would be the semi-retailers and retailers in the urban markets who have no adequate means of storing their unsold stock.

As it has been indicated this note is a provisional one only as further experiments on use of insulated containers to serve distant markets are still continuing.

MEASURING THE EFFECTIVENESS OF INSULATED FISH CONTAINERS

by

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ABSTRACT

Insulated fish containers for handling and distribution of fresh fish are becoming more important in tropical countries. Keeping fish fresh is practically impossible under most tropical conditions if insulated containers are not used.

The effectiveness of insulated fish containers can be assessed by measuring the ice-melting rate inside. The ice-melting rate will inform us how long a given quantity of ice will last inside the container and therefore how long the fish will stay at or around 0°C.

This paper describes a simple procedure to test the effectiveness of insulated containers. This test has been applied under different conditions to different types of containers. A simple mathematical model has been developed to explain the experimental results. A good relationship has been observed between the model and the experimental data.

A general comment is also included about other relevant aspects of insulated fish containers, such as hygiene, mechanical resistance, etc. The possibility of developing insulated containers using locally available material is also discussed.

1. INTRODUCTION

The amount of ice needed to keep fish fresh is economically important in tropical areas, because ice melts more quickly in warm climates. The utilization and development of locally-made insulated fish containers is spreading in many developing countries.

The basic point is that the container keeps the ice and the ice keeps the fish. Thus, the effectiveness of keeping ice becomes an important criterion for insulated containers. Economic, hygiene and handling aspects are important too.

A simple mathematical model to assess melting rates developed for uninsulated fish boxes (Boeri _et al._, 1985) has been extended in this paper to cover insulated fish containers.

Mathematical and numeric methods are available to calculate the ice-melting rate (Carslaw and Jaeger, 1959; Jaeger, 1950; Chattopadhyay and Bose, 1974; Chattopadhyay, Bose and Raychaudhuri, 1974; Chattopadhyay, Raychaudhuri and Bose, 1975). Methods to evaluate the actual heat transfer coefficient have also been developed (International Institute of Refrigeration 1970). All these methods could be applied in principle to analyse the effectiveness of fish containers. However, they require computer or laboratory facilities and heat transfer knowledge which are either scarce or non-existent in developing countries, and rarely applied under actual industrial or artisanal fisheries conditions.

The method described is a simple one to estimate ice consumption in insulated fish containers during storage and transport. The method has been tested under actual conditions with industrial and locally-made containers in Tanzania and Ethiopia with good results. Furthermore, the model proposed can be used to define the ice to fish ratio under given conditions of time, external temperature and type of container (Lupin, 1985).

2. MATERIALS AND METHODS

The industrial container tested was the Metabox 70 produced by Metas of Denmark. The principal dimensions of this container are given in Table 1.

Table 1

Metabox 70 dimensions

Dimensions	Length (m)	Breadth (m)	Height (m)
Outside	0.6	0.4	0.52 (0.54)
Inside - top	0.52	0.32	0.43
- bottom	0.5	0.3	

The insulation is polyurethane foam (3-5 cm thick), and the external surfaces of the walls and lid are polyethylene (approximately 5 mm thick).

Industrial balances (±20 g) were used to weigh the boxes. The temperature around the boxes was measured with mercury thermometers several times during the experiments and then averaged. Max-min thermometers were used when available to assess the mean temperature.

A number of locally-made and industrial containers were also tested simultaneously following the same procedures. Even though there were differences between the containers, the main features were as follows:

Walls: outer wall - palm basket or similar;

insulation - dried coconut core (or dried grass) inside two heat-sealed polyethylene bags (several "pillows" were used to insulate a container);

inner wall - palm basket or similar, plus one or two big polyethylene bags covering the surface in contact with ice and fish.

Lid: outer and inner walls - from fiber mats;

insulation - the same as in the walls.

Handles and fastening material: sisal rope.

General: 30-35 litre capacity, usable in canoes; easily transported by hand or on bicycle by only one man; resistant to rotting and to excessive increase in weight by wetting.

The only imported materials in this locally-made container are polyethylene bags, but such items can be found nowadays in most developing countries. The best prototype container was constructed by Mr R.I. Mkombachepa, a Tanzanian Fisheries Officer, and two of his colleagues during the FAO/DANIDA National Workshop on Fish Technology and Quality Control held at Mbegani, in May/June 1984. This container was called the "Bagamoyo container".

3. PROPOSED MODEL

The mathematical model to apply to ice melting in boxes was initially proposed by Boeri *et al.* (1985)and tested with ordinary fish plastic boxes at storage temperatures around or below 8°C.

To develop the model we suppose that ice is melting inside the boxes due to steady heat transfer from the exterior. In this situation, the heat transferred will be given as:

$$q_t = A.U. (T_i - T_e) \quad \text{(kcal/day)} \qquad (1)$$

where: A = area of transference (cm^2)
U = overall heat transfer coefficient (kcal/day . m^2 . °C)
T_i = temperature inside the box (usually taken as 0°C)
T_e = temperature outside the box (°C)

This heat will be counterbalanced by the heat resulting from the fusion of ice. It follows that:

$$q_f = \lambda_f \cdot \frac{dM_i}{dt} \qquad \text{(kcal/day)} \qquad (2)$$

where:

λ_f = latent heat of fusion (usually taken as 80 kcal/kg)

M_i = mass of ice (kg)

t = time (days)

In this steady state approach, quantities (1) and (2), should be equal. It follows that:

$$\frac{dM_i}{dt} = \frac{A.U.}{\lambda_f} (T_i - T_e) \qquad (3)$$

Equation (3) can be easily integrated ($T_e \neq$ constant):

$$\int_{M^o_i}^{M_i} dM_i = - \frac{A.U.}{\lambda_f} (T_e - T_i) \int_o^t dt \qquad (4)$$

where:

M^o_i = initial mass of ice (kg)

Finally:

$$M_i = M^o_i - \left[\frac{A.U.}{\lambda_f} \cdot (T_e - T_i)\right] \cdot t \qquad (5)$$

or

$$M_i = M^o_i - K.t \qquad (6)$$

where:

K = expression between brackets in equation (5)

The key point to obtain equation (6) has been to assume that the temperature outside the container will remain constant. This obviously will be impossible to achieve under actual conditions. However, constant temperatures can be assumed for short-terms trials (2-3 hours during the afternoon or after sunset), or for long trials if there are no large differences between day and night temperatures.

The melting rate constant (k) can be written in the following way:

$$K = \frac{A.U.}{\lambda_f} T_e - \frac{A.U.}{\lambda_f} \cdot T_i = K'T_e - K'.T_i \qquad (7)$$

that again is a linear equation since A, U, λ_f and T_i are constant for a given container.

When $T_i = 0$

$$K = \frac{A.U.}{\lambda_f} \cdot T_e = K'T_e \qquad (8)$$

In principle, equation (3) can be also solved if the variation of T_e with time is known. This function does not necessarily have to be analytical; a graphical or numerical method can be used to solve the integral in:

$$M_i = M^o_i - \frac{A.U.}{\lambda_f} \int_o^t \left[T_e(t) - T_i\right] dt \qquad (9)$$

provided a suitable record of coupled pairs of time-temperature values is available, together with the weight of unmelted ice. However, for a given experiment, it would be better to write (7) as follows:

$$U = \frac{\lambda_f \cdot (M^o_i - M_i)}{A \int_o^t \left[T_e(t) - T_i\right] dt} \qquad (10)$$

The U value will provide a useful tool to analyse the container's effectiveness.

Figures 1 and 2 show the theoretically expected results if the proposed model holds.

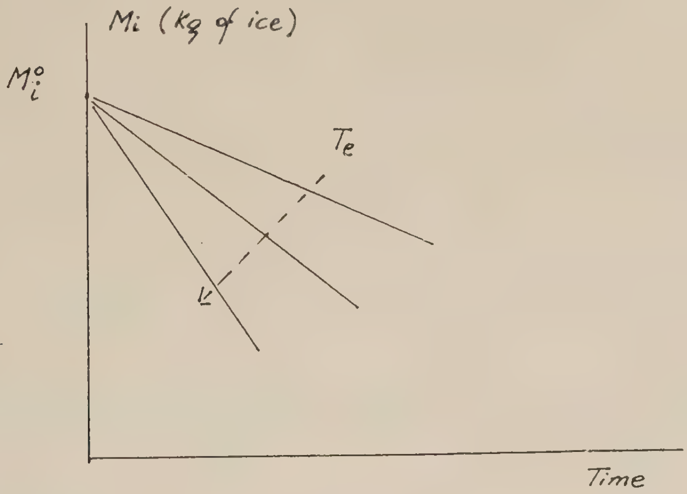

Figure 1 Theoretical ice melting rate according to equation (6)

In the experiments carried out to prepare this paper, T_i was taken as 0^oC and T_e as the average of the readings taken.

4. EXPERIMENTAL RESULTS

4.1 Ice Melting Rate

Figure 3 shows a typical result of the weight changes observed in a Metabox 70 container.

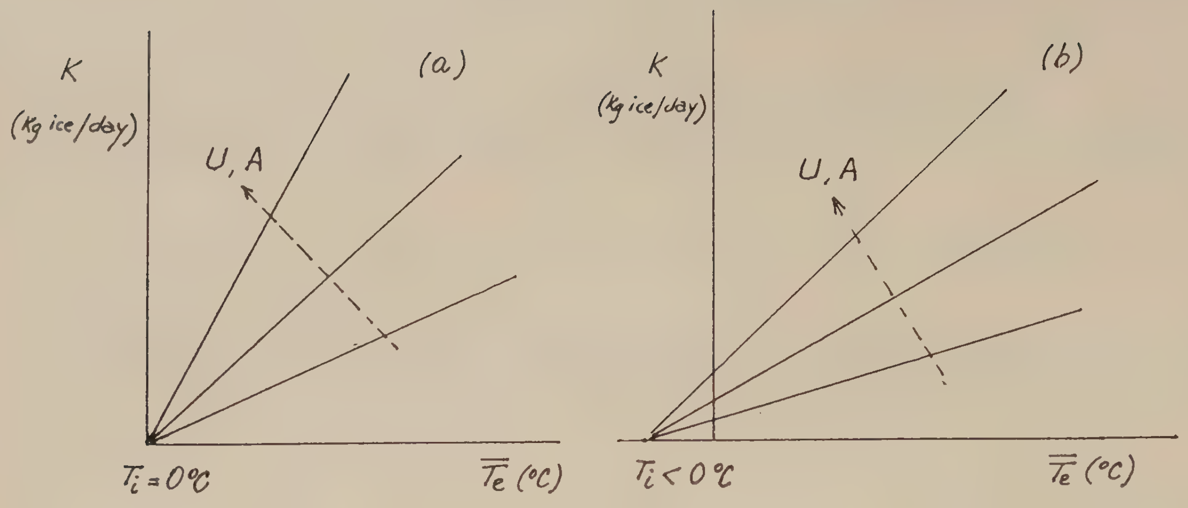
K
(kg ice/day)
(a)
U, A
$T_i = 0°C$
$\overline{T_e}$ (°C)
K
(kg ice/day)
(b)
U, A
$T_i < 0°C$
$\overline{T_e}$ (°C)

Figure 2 Specific melting rate (K) for ice made with pure water (a) and with sea water or salted water (b), according to equation (7)

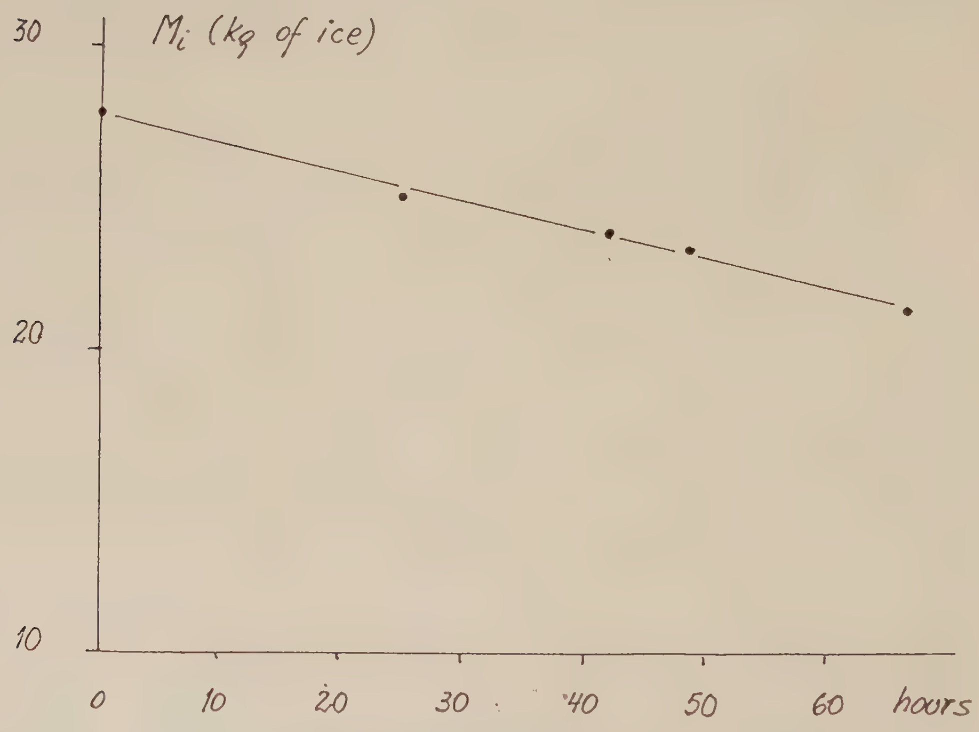

Figure 3 Typical experimental result using Metabox 70
T_e = 23.6°C Place: Ethiopia
$M_i = 28.08 - 2.38\ t$; r = 0.994

4.2 Ice Melting Rate and Temperature

Table 2 summarizes the results obtained in a total of six experiments.

Table 2

Experimental values of the specific ice melting rate

Exp. No.	K (kg/day)	T (^oC)	r	Place and date
1	3.19	27.0	0.994	Mwanza (Tanzania) Aug. '83 (13)
2	3.49	31.5	0.981	Mbegani (Tanzania) May '84 (12)
3	2.82	28.4	0.986	Mbegani (Tanzania) May '84 (12)
4	2.38	23.6	0.994	Ziway (Ethiopia) July '84
5	2.47	22.3	0.999	Ziway (Ethiopia) July '84 (13)
6	2.15	22.0	0.999	Ziway (Ethiopia) July '84 (14)

Data of Table 2 is represented in Figure 4:

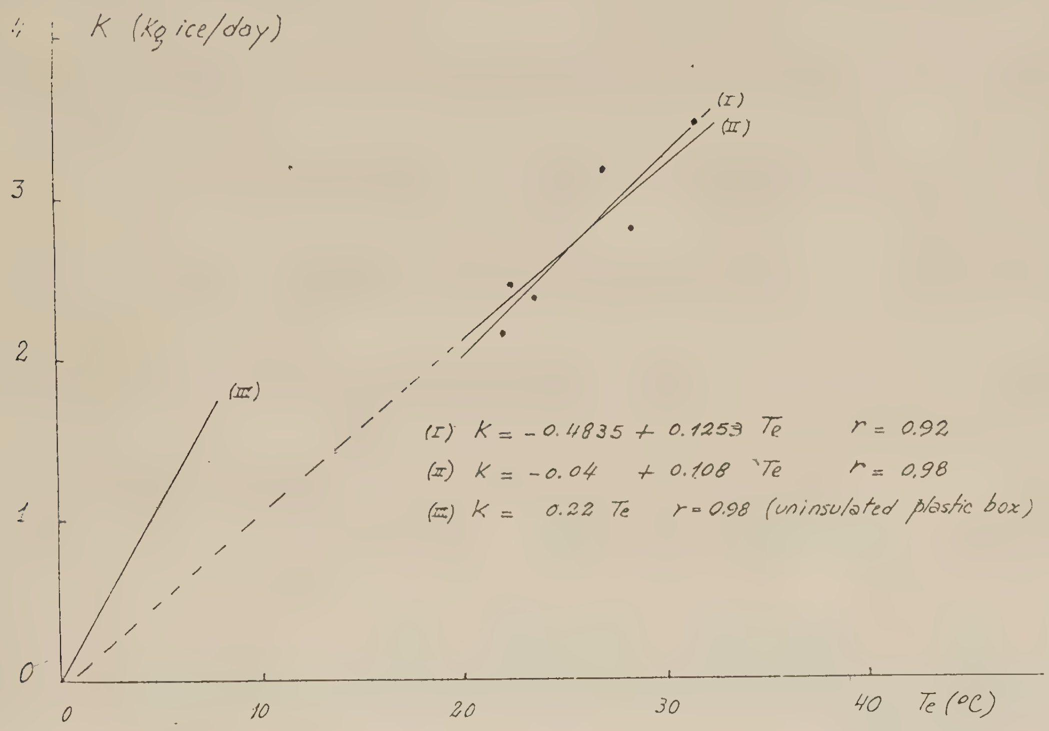

Figure 4 Experimental relationship between K and T_e. (I) Experimental data, and (II) Experimental data for uninsulated fish plastic boxes from Boeri et al., 1985 (1)

The correlation found is:

$$K\ (\text{kg/day}) = -0.4835 + 0.1253.\ T_e\ (^oC) \quad r = 0.922 \qquad (11)$$

for all the experimental data.

According to equation (7) we can say that:

$$K'(\text{EXP}) = \frac{\text{A.U.}}{f} = 0.1253 \ \frac{\text{kg (of ice melted)}}{\text{day . }^oC} \qquad (12)$$

The experimental results are reasonably well approximated by a straight line, and there are actually no great differences between the K values predicted by equation (10) and by the best straight line passing through the origin (0,0) in the range of temperatures studied. Of course, the prediction of negative values of K at low external temperatures is not correct. More experimental values seem to be necessary, mainly at low temperature, to overcome this problem.

4.3 Ice-melting Rate and the Overall Heat Transfer Coefficient

Once the relationship between K and T_e is obtained, the best approach is to calculate the experimental overall heat transfer coefficient (U) from equation (12).

$$U = \frac{K'(EXP) \cdot \lambda_f}{A} \qquad (13)$$

The definition of the true area of heat transfer (A) in containers in order to get an integrated U value is not clear. The external area is bigger than the internal area. Wall thickness is not uniform being the corners thicker. This leads to different local heat transfer coefficients.

If the container is on the floor, heat lost through the bottom will be considerably lower than heat lost through the top and sides. Heat lost through the lid will be more than through the walls, particularly if the lid is not properly fastened.

Taking into account previous experiments with fish boxes (Boeri et al., 1985) it is suggested that the true internal area (with lid on) of the container including the bottom is used in this case A = 0.9642 m.

In Table 3, the different values of the experimental parameters are compared with those resulting from the U value published by the manufacturers of the Metabox 70.

Table 3

Heat transfer parameters for Metabox 70

	U $\frac{\text{kcal}}{\text{h . m}^2 \text{ . }^o\text{C}}$	K' $\frac{\text{kg}}{\text{day . }^o\text{C}}$	Ref.
Experimental	0.433	0.1253	This work
Manufacturers	0.469	0.1356 a/	(16)

a/ Calculated applying equation (12)

The difference between corresponding values in Table 3 is around 4.6%. We can see that equation (11) will give lower values than equation (8) using the manufacturers U value. This situation is shown in Figure 5.

The difference between straight lines (I) and (II) in Figure 5 is almost constant. It could represent an error of + 4°C in experimental temperature readings. Most of the temperature values used to obtain the averages were taken during the day time. If night time temperature values were not taken in general, then the actual experimental average temperature might be lower than that indicated in Table 2, in each case. There is no possibility of correcting Table 2 since no records are available.

The role of the true average temperature can be better understood if it is defined as follows:

$$\bar{T}_e = \frac{\int_o^t T_e(t)\, dt}{\int_o^t dt} \qquad (14)$$

Replacing equation (14) in equation (9) gives:

$$M_i = M_i^o - \left[\frac{A.U.}{\lambda_f} \cdot (\bar{T}_e - T_i)\right] \cdot t \qquad (15)$$

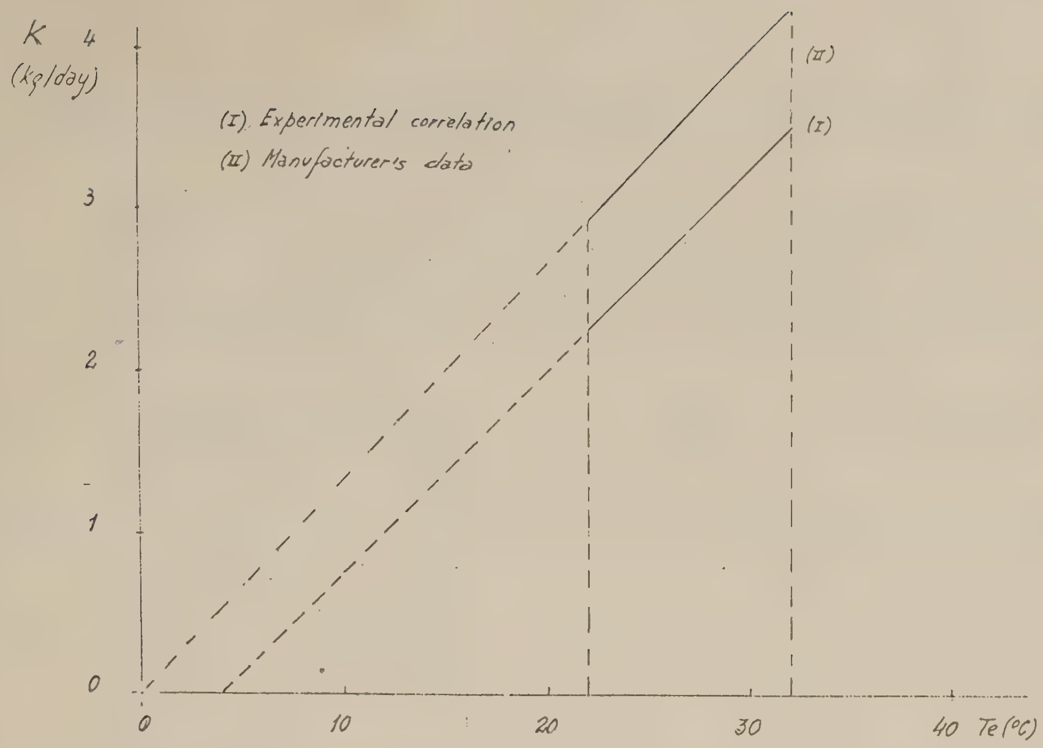

Figure 5 Ice-melting rates in Metabox 70: (I) Experimental, (II) Based on technical data published by the manufacturers

Equation (15) is basically equivalent to equation (5), and an equation similar to (6) can be obtained. However $\bar{T}_e$ has a more precise meaning.

4.4 Some Results Obtained with Locally-produced Containers

During the FAO/DANIDA Workshop Programme on Fish Technology and Quality Control, containers were constructed by the participants, and their characteristics tested by determination of K, equation (6).

Table 4 shows some of the data obtained during the experiments. A good correlation is in general found between the experimental points and equation (6). The values of K given in Table 4 are only indicative since a deeper study of the relationship between K and T_e is necessary to evaluate the corresponding overall heat transfer (U). It is likely that different thermal characteristics may be found in locally-produced containers even when the same construction is used.

However, we can see from Table 4 that the K values are quite low and a longer melting time can be expected. Direct comparison between K values is not possible since the area of the containers should be taken into account. For example, in comparative trials, the Mwanza container rated 40% lower than the Metas container, whereas the Bagamoyo container rated only 10% lower, from the thermal point of view. In another comparative trial, the Bagamoyo container rated 25% over other industrial-made insulated fish containers (not Metas), a remarkable achievement.

5. DISCUSSION AND CONCLUSIONS

The model proposed fits the experimental results obtained from testing industrial and locally-produced containers. The test carried out on a well-known industrial container (Metabox 70) gave an opportunity to analyse the main experimental problems that can arise in practice.

More attention should be paid in practice to the determination of the true average temperature. The following procedures are recommended:

(a) to perform short trials (6-8 h) during day time, measuring temperature each hour, and ice every two hours;

(b) to use max-min thermometers for experiments overnight (from sunset to sunrise); and

(c) to utilize time-temperature recorders if available (this is the most expensive solution).

Table 4

Characteristics of artisanal containers

Place	K (kg/h)	r correla. coeffic.	T (^oC)	V (litres)	Description
Mwanza[a/]	0.1454	0.997	27	22.5	Two baskets; insulation: saw dust + gunnybag; lid: wet gunny bags
Bagamoyo[b/]	0.1203	0.994	27	35.3	Two baskets; insulation: coconut core in plastic bags; lid: mats + insulation
Ziway[a/]	0.1266	0.99	23	15.0	Two baskets; insulation: dry grass in plastic bags lid: mats + insulation
Ziway[c/]	0.102	0.99	223	15.0	Same as above but better constructed (more insulation + more tightly packed
Ziway[c/]	0.088	0.99	22	19.0	Wooden box 1.5 cm thick + plastic bag in the interior

a/ Rathacharen et al., 1983
b/ Mkombachepa, Chingumbe and Nyalapa, 1984
c/ Tesfamariam et al., 1984

Measurement of dimensions (external and internal) of artisanal containers should be done carefully, if a true value of the overall heat transfer coefficient is sought. The experimental value of U is quite sensitive to small variations in the value assigned to the area.

In general, the model proposed could be used as a guideline for the development and improvement of artisanal containers. The method proposed here can be used in comparison trials between two types of containers, provided the experiments are done simultaneously. From equation (15), taking subindex 1 for container A, and subindex 2 for container B, we can write:

$$\frac{\frac{A_1 U_1}{\lambda_f}(\bar{T}_e - T_i)}{\frac{A_2 U_2}{\lambda_f}(\bar{T}_e - T_i)} = \frac{K_1(EXP)}{K_2(EXP)} \qquad (16)$$

As the comparison is done simultaneously, the histories time-temperature are the same for both containers, so:

$$\frac{A_1 \cdot U_1}{A_2 U_2} = \frac{K_1(EXP)}{K_2(EXP)} \qquad (17)$$

Finally:

$$\frac{U_1}{U_2} = \frac{A_2 \cdot K_1(EXP)}{A_1 K_2(EXP)} \qquad (18)$$

If the equation (18) ratio is lower than one, container A will have better insulation than container B, or vice-versa if the ratio is higher than one. An estimation of one of the overall heat transfer coefficients can be made (say U_1) if we know the other one (U_2) from previous experiments.

It should be noted that if only the comparison between two different containers is sought, then an accurate record of temperatures is not necessary, provided that both containers are stored under the same external conditions. However, an accurate measurement of internal and external areas continue to be important.

The model proposed here could also be useful to re-analyse experimental data published by other authors, e.g., Villadsen, Gunaratne and Jinadasa, 1979; and Etoh and Perera, 1979, who worked on the development and comparison of different types of locally-produced containers.

In practice, other aspects of container effectiveness are also important once good insulation is secured. In general, physical, economic, hygienic and processing factors are also important.

From the physical point of view, a high net volume to area ratio is desirable; light containers are desirable; the container should last an acceptable period and heat losses through the fastening between lid and body, or through drainages should be minimised.

From the economic point of view, a container should be cheap (this should also take into account the life-span), possible to replace at the end of its life-span, easy to transport and distribute. It should be possible to reuse the material of the fish container at the end of its life-span, or repair the container.

The hygienic factor is quite obvious; the container should not be a source of contamination. The surfaces in contact with fish and ice should be cleaned every time.

From the processing point of view, the container should be easy to handle, easy to stack (if necessary), and easy to individualize (if necessary).

As in many other things the completely "ideal" fish container does not exist. However, compromise solutions can be achieved in practice.

Observation indicates that in developing countries fishermen are adopting the idea of insulated containers. Locally-made containers can be seen in different countries in Asia, Africa and Latin America. They are not always cheap or suitable and this opens a quite good field of research and development for institutes in developing countries. This paper has been written with the aim of helping and encouraging such activity.

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HOW TO DETERMINE THE RIGHT FISH TO ICE RATIO FOR INSULATED FISH CONTAINERS

by

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ABSTRACT

A practical problem when using insulated fish containers or fish boxes is how to determine the fish to ice ratio according to the prevailing conditions.

The practical rules (e.g., 50% fish + 50% ice) usually found in technical publications, have proved to be unsuitable for tropical and sub-tropical conditions. Moreover, the "practical" rules tend to conceal the fact that the right fish to ice ratio mainly depends on external temperature, distribution and storage time, and type of container.

This paper presents a simple procedure to calculate the fish to ice ratio. This procedure is based on a model presented earlier (Lupin, 1985) that has been tested in practice. Some examples were worked out to show how the method can be applied.

The method described here can be applied in a rational way to study other relevant aspects of icing, such as planning of ice facilities, icing costs, etc.

1. INTRODUCTION

The practical rules usually found in technical publications (Myers, 1981; Clucas, 1981; FAO, 1974) to determine the fish to ice ratio cannot be applied in general to tropical and semi-tropical conditions.

In practice, most of the time, ice does not last since it melts more quickly in warm environments and fish are lost; sometimes valuable ice, and transportation and storage space are lost. Coupled with these physical constraints, there is an economic one. In developed countries with temperate and cold climates, ice is a very cheap commodity, whereas in sub-tropical and tropical countries ice is usually an expensive item. For example, in Dar es-Salaam (Tanzania), ice in March 1984 was being sold at T.Sh. 2/kg, the equivalent of US$ 0.16/kg. In developed countries fishermen can usually buy ice at a price 10 times lower (Myers, 1981). The problem of availability of ice is also to be considered.

When we couple both factors, the final cost of ice for fresh fish could be as much as 20 times higher in tropical and sub-tropical countries than in temperate and cold weather countries. This will not only affect the fish prices internally, but it will also reduce the possibility of offering competitive prices in the international fish market, since the cost of ice will affect the cost of all the products.

It is likely that in this situation the quality of fish will be affected since the idea of ice savings will always be present. From the obvious choice of using less ice than is necessary, to the apparently innocent practice of using ice that fell on the floor (Lisac, 1984), wrong practices may arise that will contribute to damaging the quality of fish.

In this situation the use of ice should be rationalized in order to reduce ice consumption, but without affecting quality. The ice melting rate can be reduced by using insulated containers. The ice melting rate depends on the insulating material, the external temperature, and the geometry of the container (Lupin, 1985).

This paper describes a method for calculating the appropriate fish to ice ratio for a given type of container, storage and distribution times and temperature.

2. PROPOSED METHOD

In general we can say that the mass of ice in a container which holds fish and ice will be:

$$\left\{\text{Mass of ice}\right\} = \left\{\begin{matrix}\text{Initial mass}\\ \text{of ice}\end{matrix}\right\} - \left\{\begin{matrix}\text{Ice necessary to}\\ \text{cool fish to } 0^{\circ}\text{C}\end{matrix}\right\} - \left\{\text{Ice losses}\right\} \qquad (1)$$

where:

$$\left\{\text{Mass of ice}\right\} = M_i \ (\text{kg}) \qquad (2)$$

$$\left\{\text{Initial mass of ice}\right\} = M^o{}_i \ (\text{kg}) \qquad (3)$$

$$\left\{\begin{matrix}\text{Ice necessary to cool}\\ \text{fish to } 0^{\circ}\text{C}\end{matrix}\right\} = \frac{C_{pf} \cdot T_f}{\lambda} \cdot M_f \qquad (4)$$

$$\left\{\text{Ice losses}\right\} = K^1 \cdot \overline{T}_e \cdot t \qquad (5)$$

where:

C_{pf} = specific heat capacity of fish $\left(\frac{\text{kcal}}{\text{kg} \cdot {}^{\circ}\text{C}}\right)$
T_f = temperature of the fish just before being iced ($^{\circ}$C)
t = time elapsed since icing (hours)
λ = latent heat of fusion of ice (usually taken as 80 kcal/kg)
K^1 = specific ice-melting rate of the container $\left(\frac{\text{kg}}{\text{hours} \cdot {}^{\circ}\text{C}}\right)$
$\overline{T}_e$ = external average temperature ($^{\circ}$C)
M_f = mass of fish in the container (kg)

Equation (5) has been taken from the model given previously (Lupin, 1985). The specific heat capacity of fish (C_{pf}) can be calculated according to the equation suggested by Charm (1971):

$$C_{pf} = 0.5\ X_F + 0.3\ X_s + 1.0\ X_m \qquad (6)$$

where:

X_F = mass fraction of lipids in fish (g/g)
X_s = mass fraction of solids in fish (g/g)
X_m = mass fraction of water in fish (g/g)

The specific heat capacity will be, according to Equation (6), around 0.80 $\frac{\text{kcal}}{\text{kg} \cdot {}^{\circ}\text{C}}$ for lean fish, 0.78 $\frac{\text{kcal}}{\text{kg} \cdot {}^{\circ}\text{C}}$ for medium fatty fish and 0.75 $\frac{\text{kcal}}{\text{kg} \cdot {}^{\circ}\text{C}}$ for fatty fish.

Replacing the expressions (2), (3), (4) and (5) mentioned in Equation (1) we obtain:

$$M_i(t) = M^o{}_i \ \frac{C_{pf} \cdot T_f}{\lambda} \cdot M_f - K^1 \cdot \overline{T}_e \cdot t \qquad (1a)$$

In practice, a ratio fish to ice (or ice to fish) is defined as follows:

$$\frac{M_f}{M^o{}_i} = n, \quad n = 1,\ 1.5,\ 2,\ \text{etc.} \qquad (7)$$

or

$$M_f = n \cdot M^o{}_i \qquad (8)$$

Also, as a container has a finite volume, the following relationship holds at t = o, assuming the container is completely full:

$$V_c = M_f \cdot \rho_f + M^o_i \cdot \rho_i \qquad (9)$$

where:

V_c = internal (utilizable) volume of the container (cm^3)
ρ_f = specific volume of fish stowed (cm^3/kg)
ρ_i = specific volume of ice stowed (cm^3/kg)

For example, in the experiments mentioned by Lupin (1985) the values of ρ_f and ρ_i were:

ρ_f = 1 274 cm^3/kg (barracuda - Sphyraena spp. Tanzania)
ρ_i = 1 731 cm^3/kg (flake ice)

It should be said that ρ_f and ρ_i can be determined in actual conditions quite easily by weighing a known volume of fish or ice.

Replacing Equation (8) in Equation (1a) gives:

$$M_i(t) = M^o_i \ (1 \ \frac{C_{pf} \cdot T_f}{\lambda} \cdot n) \ - K' \cdot \overline{T}_e \cdot t \qquad (1b)$$

Replacing Equation (8) in Equation (9) gives:

$$V_c = M^o_i \ (\rho_i + \rho_f \cdot n) \qquad (10)$$

Now replacing Equation (10) in Equation (1b) gives:

$$M_i(t) = \frac{V_c}{(\rho_i + \rho_f \cdot n)} \ (1 \ \frac{C_{pf} \cdot T_f}{\lambda} \cdot n) - K^1 \cdot \overline{T}_e \cdot t \qquad (11)$$

To determine how long ice will last in the container, we take:

$$M_i(t) = 0 \qquad (12)$$

in this case from Equation (11) gives:

$$t_{MAX} = \frac{V_c}{K'(n\rho_f + \rho_i) \cdot \overline{T}_e} \cdot (1 \ \frac{C_{pf} \cdot T_f}{\lambda} \cdot n) \qquad (13)$$

Equation (13) can be used directly in actual cases; however, it is more useful from the practical point of view to find an expression for n, since t_{MAX} is usually fixed by the conditions of storage and for transport.

In practice, t_{MAX} will vary according to n, for a given set of conditions (V_c, K^1, ρ_f, ρ_i, $\overline{T}_e$, C_{pf} and T_f). These values of t_{MAX} range from negative values (when ice is not enough even to cool the fish to 0°C), or 0 (when ice is just enough to cool the fish to 0°C), till a t^*_{MAX} when no fish are in the container and all the ice is used to compensate heat losses, in this case:

$$t^*_{MAX} = \frac{V_c}{\rho_i \cdot K' \cdot \overline{T}_e} \qquad (14)$$

Equation (14) can be easily obtained from Equation (1b) for n = 0.

Dividing Equation (13) by Equation (14) gives:

$$\frac{t_{MAX}}{t^*_{MAX}} = \frac{1}{(1 + n \cdot \frac{\rho_f}{\rho_i})} \ (1 \ \frac{C_{pf} \cdot T_f}{\lambda} \cdot n) \qquad (15)$$

Equation (15) is very useful because it is a general one (it is independent of the type of container). It is obvious from Equation (15) that the ratio t_{MAX}/t^*_{MAX} should always be lower than one. Equation (15) can be rearranged to:

$$n = \left(\frac{i}{\rho_f}\right) \cdot \frac{1 - \dfrac{t_{MAX}}{t^*_{MAX}}}{\dfrac{t_{MAX}}{t^*_{MAX}} + \left(\dfrac{\rho_i}{\rho_f}\right) \dfrac{C_{pf} \cdot T_f}{\lambda}} \qquad (16)$$

Equation (16) is represented in Figure 1 for three different fish temperatures.

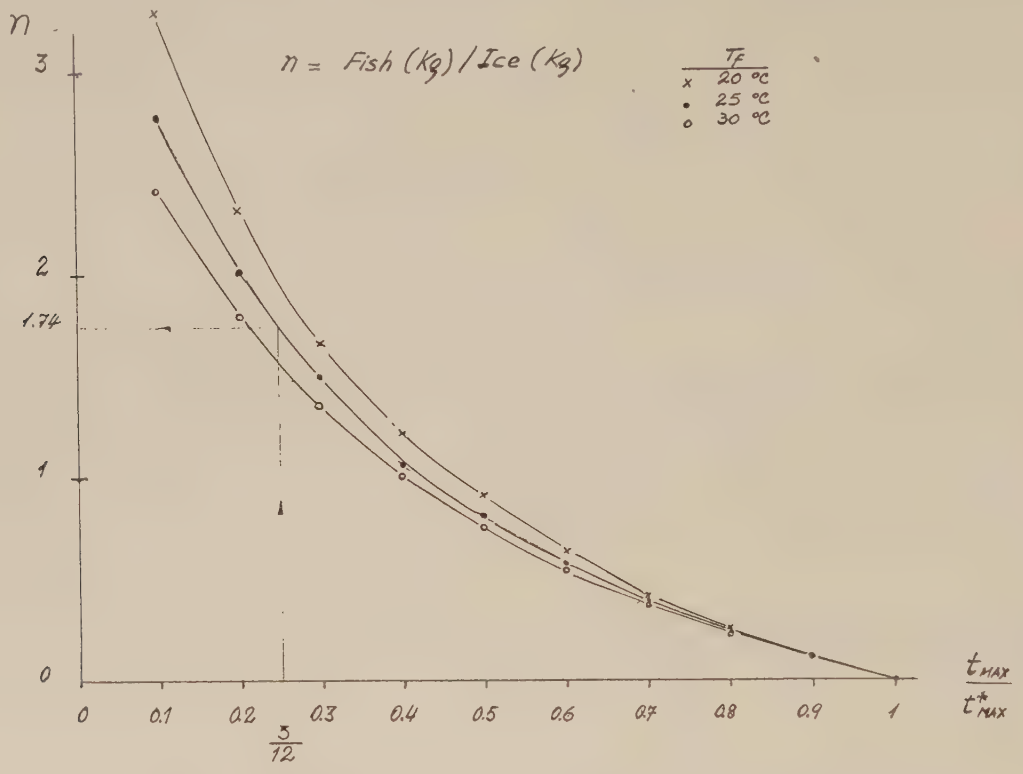

Figure 1 Fish to ice ratio to satisfy a given t_{MAX}/t^*_{MAX} ratio. ρ_f = 1 274 cm^3/kg, ρ_i = 1 731 cm^3/kg

On the other hand, we can represent t^*_{MAX} as a function of $\overline{T}_e$ for a given type of container, using Equation (14). Equation (14) is represented in Figure 2 for the Metabox 70 container previously studied (Lupin, 1985).

Figure 2 can be determined after an evaluation of the effectiveness of the container as was shown in a previous paper (Lupin, 1985).

2.1 How to Apply the Method

The steps to determine the right fish to ice ratio for a given set of conditions are:

(a) determine the thermal characteristics of your container. This can be done as outlined by Lupin (1985), or from technical information supplied by the manufacturers of some industrial containers.

Basically, in this step, you should determine K', V_c and ρ_i. With this information you can use Equation (14) or construct a figure like Figure 2 for your container;

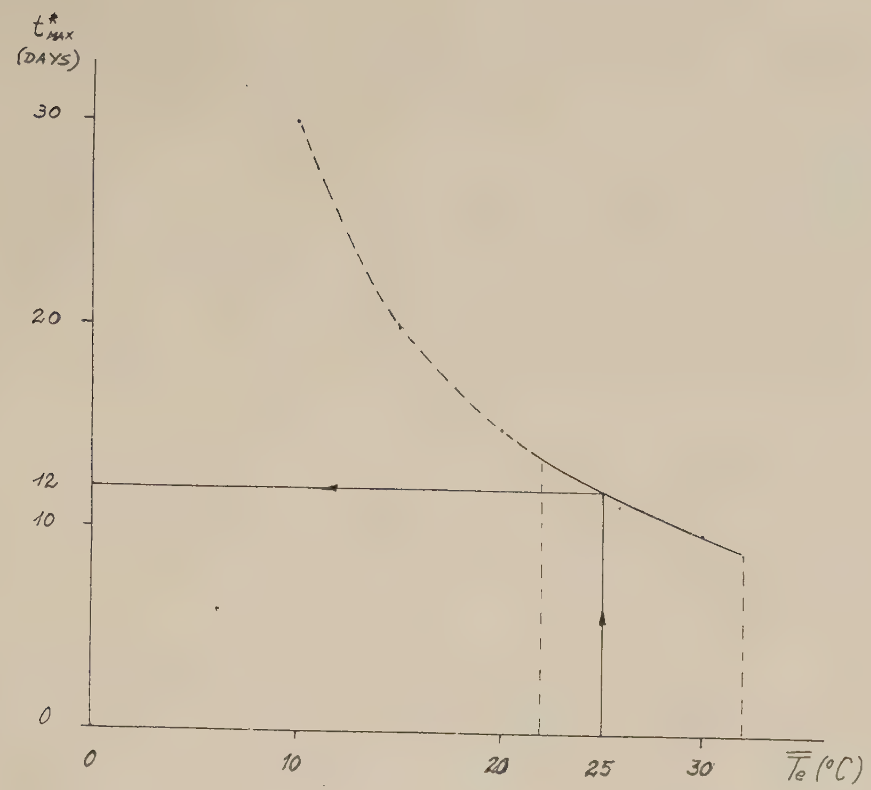

Figure 2 t^*_{MAX} as function of T_e for the Metabox 70 container

(b) determine all the parameters you need for your calculations

ρ_f - from the type of fish you are going to ice
C_{pf} - from the composition of the fish you are going to ice
T_f - from the average temperature of the fish after capture (usually the water temperature)

With this information you can use Equation (15) and construct a figure like Figure 1 to suit your conditions (given by ρ_i, ρ_f, C_{pf} and T_f);

(c) assess the length of time the fish will need ice:

- before landing
- before it reaches the market
- before it is sold at the market

or some combination of the three according to the situation in which the container will be actually used.

It is important to assess this time as carefully as possible. In this step you will fix t_{MAX}, i.e., the time fish should be with ice inside the container before landing, processing, selling, etc.;

(d) assess the external average temperature ($\bar{T}_e$) for the period you intend to make recommendations.

Now you have the necessary information for determing the right fish to ice ratio. If you want to calculate it numerically, you should start calculating t^*_{MAX} from Equation (14), and then n from Equation (16).

2.2 A Worked-out Example

We are going to apply Equations (14) and (16) to the Metabox 70 for the following conditions:

V_c = 64 821 cm^3 (with lid on)
ρ_i = 1 731 cm^3/kg
ρf = 1 274 cm^3/kg

$C_{pf} = 0.8$ $T_f = 25^\circ C$ $\bar{T}_e = 25^\circ C$

$$K' = 0.1253 \frac{kg}{day \cdot {}^\circ C}$$

$t_{MAX} = 3$ days (in this example t_{MAX} must be at least 3 days)

From Equation (14) results:

$$t^*_{MAX} = \frac{64\ 821}{1\ 731 \times 0.1253 \times 25} = 11.95 \cong 12 \text{ days}$$

From Equation (16):

$$n = \left(\frac{1\ 731}{1\ 274}\right) \frac{1 - \frac{3}{12}}{\frac{3}{12} + \left(\frac{1\ 731}{1\ 274}\right) \frac{0.8 \times 25}{80}} = 1.728 \cong 1.73 \ \frac{\text{kg of fish}}{\text{kg of ice}}$$

The same example is repeated in Figures 1 and 2 to determine graphically the right value of n. From Figure 2 with $\bar{T}_e$ gives t^*_{MAX}, in this case 12 days. From Figure 1 with the ratio t_{MAX}/t^*_{MAX}, in this case 3/12 or 0.25, gives n = 1.74, which is similar to the result obtained numerically.

The graphical procedure could be of interest for extension workers in the field.

3. THE FISH TO ICE RATIO AND ICING COST

The method developed in this paper may appear to be a rather academic exercise; however, we are going to present a way to study the influence of the fish to ice ratio on the cost of icing fish in containers.

The value of n can be used to obtain better calculations on the cost of icing fish in containers. For example, the following equation can be used to estimate the relative influence of the cost of the container and the cost of ice:

$$IC(N) = \left(\rho_f + \frac{\rho_i}{n}\right) \frac{\begin{bmatrix}\text{fixed}\\ \text{cost}\end{bmatrix}}{V_c \cdot N} + \frac{1}{n} \begin{bmatrix}\text{Ice}\\ \text{cost}\\ \text{US\$/kg}\end{bmatrix} \qquad (17)$$

IC(N) = cost of ice per kg of fish transported and stored, etc., during the life span of the container (after N cycles)

N = times the container is used

The type of container and the conditions will influence IC(N) through V_c, n and N (durability). The value of n will be obtained from Equation (16). In general, Equation (17) is represented in Figure 3. As can be seen, IC(N) will decrease with N. However, the lower limit is determined by the cost of ice and n.

N* in Figure 3 indicates the number of times when the two terms of the right hand of Equation (17) are equal. Above N* the cost of ice will be higher than the relative cost of the container.

Equation (17) is not complete. We can expand it, for example, by adding a wage term as follows:

$$IC(N) = \left(\rho_f + \frac{\rho_i}{n}\right) \frac{\begin{bmatrix}\text{Fixed}\\ \text{Cost}\end{bmatrix}}{V_c \cdot N} + - \begin{bmatrix}\text{Ice cost}\\ \text{US\$/kg}\end{bmatrix} + \begin{bmatrix}\text{Wages}\\ \text{cost}\\ \text{per hour}\end{bmatrix} \cdot \frac{\left(\rho_f + \frac{\rho_i}{n}\right)}{m \cdot V_c} \qquad (17a)$$

where:

m = number of containers iced in one hour (productivity)

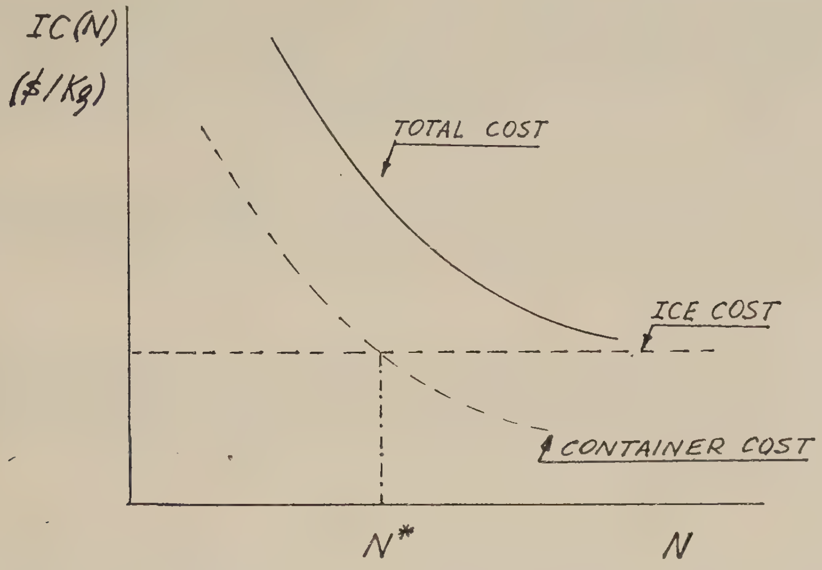

Figure 3 Scheme of the ice cost variation verses the number of times the container is utilized

Again, we can see that the fish to ice ratio will affect the incidence of the relative cost of wages. The higher the fish to ice ratio, the lower the relative incidence of wage costs for icing.

A numerical example using Equation (17a) is given in Table 1 and compares two different situations. Case A is likely to be a developing country with a tropical climate; case B is likely to be a developed with a temperate climate. The same container, the same type of fish, the same productivity (m) and the same working cycle are used in the example for each case. The different conditions are: external average temperature (25°C and 10°C), cost of ice (US$ 0.16/kg to US$ 0.017/kg), and wage cost (US$ 0.25/hour to US$ 5.00/hour).

After analysing Table 1, we can conclude the following:

(a) the cost of icing in type A countries will be higher than in type B countries. A 20-times difference in wage cost cannot offset a 10-times difference in cost of ice;

(b) in countries like A the main factor in the cost equation will be the ice cost, in B-like countries the main in factor will be the wage cost;

(c) relative cost of ice in type B countries is so low (7.6% of the total after one year) compared with the other costs that the fish to ice ratio can be varied without introducing large changes. On the other hand, in type A countries the relative cost of ice is so high that a variation in n will introduce large changes in the total cost;

(d) in type B countries, the main concern will be to increase m in order to reduce the incidence of wage costs. The m value could be increased, for example, by introducing a special chute to handle the ice, and a special table to handle the containers, etc. These improvements, making work even easier, will not greatly change the cost of icing in type A countries;

(e) in type A countries, the main concern should be the increase in the fish to ice ratio (n). Wages could be eventually increased without affecting the total cost too much.

Even though some observations can be made from the calculations in Table 1 (e.g., there are some costs like storage and transportation that have not been considered; the problem has been only from the point of view of cost and not as a whole inversion, situatons A and B may be considered extreme cases, etc.), the concept of the importance of the fish to ice ratio (n) remains constant.

The values of the parameters used in Table 1 are actual values of an existing container and working and weather conditions; moreover, points (a) to (e) arise from practical observations in many countries.

Incidentally, Table 1 explains why in some tropical developing countries it is possible to find large and expensive home-made metallic containers. Even though they are costly, they do not affect the total cost of icing probably because the incidence on the cost per kilogramme of iced fish is negligible after one year or so. Even more, the containers tend to be large in order to reduce the area/volume ratio which in turn will increase the fish to ice ratio (ice will melt more quickly in four containers measuring 0.25 m^3 than in one container measuring 1 m^3, assuming they have the same type and thickness of insulation).

Fishermen may not know about the fish to ice ratio or cost calculations, but they will certainly tend to optimize from experience. As found in other instances the cost of the container is quickly paid for by the savings on ice in tropical conditions (Villadsen, Gunaratne and Jinadasa, 1979).

4. DISCUSSION AND CONCLUSIONS

The method presented here is advanced regarding existing practical rules for determining fish to ice (or ice to fish) ratio. It can be applied easily, and all the necessary parameters can be determined in actual field conditions. The necessary instruments for measuring commercial scales, ordinary thermometers and a ruler can be found in practice. The method can be presented in a graph for easy use by field officers.

Furthermore, the method can be used to determine the suitability of a given container under a given set of conditions. Actually, I started to work on this method after I saw (in a developing country) a storehouse full of insulated containers that were not used because they were found unsuitable in practice. These containers looked very nice, but when tested they performed rather poorly; probably they did not have enough insulation, and the lids were too loose, thus allowing further heat losses. It is clear if the t_{MAX} is around or higher than t^*_{MAX}, the container will not be suitable.

The importance of the fish to ice ratio in the cost of ice for fish in tropical countries has also been emphasized. Thus, the introduction of insulated fish containers can be studied from another point of view, besides the classic approaches of increasing the quality of fish and reduction of post-harvest losses (incidentally low priced fresh fish or around the cost of ice is most likely to be lost under actual conditions).

Even though a more in-depth study is necessary to analyse specific cases, it seems that the cost of ice could be the limiting factor on icing fish in tropical countries rather than the cost of the containers (see the example discussed at the end of Section 3).

The results show that there is plenty of room for the development and introduction of locally made containers; a task that can be undertaken by the research institutes in developing countries. The main contribution of the institutes can be to:

(a) develop containers suited to local conditions that are more efficient than the containers already used by the fishermen;

(b) obtain a clear picture about the economics of icing fish in order to advise government, fishermen and the fishery industry.

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EXPERIMENT AND ECONOMIC EVALUATION OF IMPROVED HANDLING OF FISH USING INSULATED CONTAINERS

by

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ABSTRACT

Improved handling and shipment of fish is important to retard spoilage. The storage life of Tilapia spp. and Lates niloticus held at ambient temperature and iced immediately after landing has been studied through observation of changes in organoleptic characteristics. At ambient temperature the two become inedible within two days after capture. Since the storage life in ice was found to be 12 days, the introduction of proper icing procedures can contribute greatly to improving supplies of good quality fish to urban markets.

Problems connected with the present situation and consumers' reactions encountered while conducting the experiments are discussed. Some proposals for improving the handling, storage and shipment of fish in the country are made.

1. INTRODUCTION

1.1 Background Information

Lake Victoria, located 1 100 m above sea level, is one of the largest lakes in the world with a total area of 68 635 km^2. Its waters fall within the national boundaries of Kenya, Uganda and Tanzania. The Kenya waters of Lake Victoria have a total area of 5 490 km^2. The Kenya portion is the smallest, but most experts agree that Kenya's Nyanza Gulf is one of its most productive parts. The total fish production in the Nyanza Gulf in 1982 was 60 958 t, worth K Sh 123 400 000 and in 1983, 77 328 t worth K Sh 120 315 000 to the fishermen, respectively (see Table 5).

The fishery of the Kenya waters of Lake Victoria is based mainly on the use of gillnets. In addition to gillnets, longlines, beach seines and trawlnets are also used. At present no fisherman uses trawlnet and the use of trawlnet is still dominated by institutions such as the Department of Fisheries and Kenya Marine and Fisheries Research Institute based in Kisumu. The fishing craft used on the Nyanza Gulf of Lake Victoria are mainly traditional.

The importance of fish as a source of animal protein has been generally recognized in Kenya and in recent years, the Department of Fisheries has engaged in intensive programmes to develop the fishing industry. Kenya being among the developing countries, fish could thus be the main protein source for the many new consumers. Fish products such as hot smoked fish, fried fish and sundried fish have also been used to counteract the problem of malnutrition. Freshwater fish are one of the main sources of animal protein in the diet of people living around the Nyanza Gulf of Lake Victoria. Most of the fish is processed. However, the demand for fresh fish is higher than for processed fish and for this reason, there is an urgent need to improve handling of fish under local conditions. The introduction of modern fishing methods in Kenya waters of Lake Victoria has increased the catch considerably, but difficulties in transport as well as non-availability of ice and insulated containers has restricted movement of fresh fish to distant centres.

1.2 Terms of Reference

The experiment was carried out under the FAO Regional Cooperative Research Programme in fish technology and grant-in-aid provided by FAO Project GCP/INT/398/NOR to improve handling of fish using insulated containers.

This project is the outcome of a previous project carried out in Tanzania at the Freshwater Fisheries Institute Nyegezi at Mwanza with support of FAO/DANIDA Project GCP/INT/298/DEN to improve the handling of small pelagic fish. The first project is aimed at strengthening cooperation between countries bordering Lake Victoria. For this reason, Fisheries Officers from Tanzania, Uganda and Kenya were invited to participate and the writer represented the Kenya Government.

The project in Tanzania, otherwise known as Mwanza experiments on "Effect of Handling Practices on the Keeping Quality of Fish" caught in Lake Victoria, was conducted between January and February 1982.

The initiatives for the Kenya project started in March 1983, with a formal request to FAO by the Government of the Republic of Kenya through the Department of Fisheries. From then onward intensive consultations between the parties concerned continued, culminating in a formal agreement in March 1984. This agreement outlined among other things, funding of the project and the general conditions. While all concerned wanted and expected the project to be off the ground as soon as the agreement was concluded, unfortunately due to some unforeseen circumstances it was not possible to start it until 17 July 1984.

The main objective of this project was to demonstrate the possibility of shipping fish in ice to distant urban markets thus reducing spoilage in order to provide consumers with high quality fish and fish products and also to carry out an economic evaluation of improved handling of fish using insulated containers. To meet this objective, 10 insulated containers were provided by FAO Headquarters in Rome; two were of 200-litre capacity and eight were of 70 litres.

2. MATERIALS AND METHODS

2.1 Material

The experiment was carried out in the months of July, August, September and October, 1984. Two species, namely Tilapia spp. (Ngege) and Lates niloticus, Nile perch (Mbuta) were used. Fish were caught by fishermen and the journey from the fishing ground to the fish-landing beach took between two to five hours. To simulate local practices, no preservation by cooling was applied on board the fishing craft. Following the establishment of a 1.5-t/3 h block ice plant in Kisumu by M/S Samaki Products Ltd, enough ice blocks were carried in the insulated containers on each trip to the fish-landing beach. On the landing beach, temperatures of surface water were recorded and were between 24°C and 26°C. at the lake shore.

The fish landing beaches identified for the purpose of the experiment were: Kaloka, Paga, Dunga in Kisumu district and Uhanya, Luanda Kotieno in Siaya district (see Appendix 2).

The fish were subjected to four treatments and in each case a ratio of 2:1 (ice to fish) was applied.

LOT A: Whole, medium size Lates niloticus were washed to remove the thick surface slime, gutted, washed again and put in the 200-litre insulated container with ice.

LOT B: Whole lates niloticus were washed, filleted and packed individually in polythene bags before icing in a 200-litre insulated container.

LOT C: Whole ungutted Tilapia spp. were washed and iced in 70-litre insulated containers.

LOT D: Whole gutted Tilapia spp. were washed, wrapped individually in polythene bags, packed belly downward and iced in 70-litre insulated containers.

2.2 Methods

At the premises of M/S Samaki Products Ltd. in Kisumu town and city market in Nairobi among others, random daily observations of the physical characteristics were made to assess the fish quality changes during storage.

2.3 Experimental Procedures

The fish purchased were sorted into sizes, weighed in order to obtain different prices to suit different buyers. Some fish were gutted, others filleted while the remainder were ungutted. When packing into insulated containers, Lates niloticus and Tilapia spp. were kept separately. All the fish were kept in their designed storage conditions for subsequent sales at distant urban markets. The main problem in the storage and transportation of iced fish is to ensure that its temperature on arrival at the destination is still near to 0°C. Icing of fish and fish products (fillets) was carried out as follows: a layer of ice on the bottom/fish/ice/fish and finally a deep layer of ice on top, and the container closed.

3. TRANSPORT OF FISH

3.1 Transport from Fish-Landing Beaches to Kisumu Town

The journeys from fish-landing beaches to Kisumu Town took between 30 min and 3 h, depending on the type of transport used and the distance involved. In most trips public transport was used. The details of the problems encountered with the insulated containers are discussed elsewhere in this document.

On arrival in Kisumu, the fish went straight to the premises of M/S Samaki Products Ltd.' At the premises, each container was opened and temperatures recorded. Temperatures ranged between 5°C and 10°C. At the same time observations on physical characteristics were made to assess the condition of both fish and ice after 2-4 days of storage. The amount of ice used in each insulated container was expected to remain at the end of the journey, but this was not the case.

3.2 Results

The results showed that there was a higher melting rate of ice in Lot A and Lot B than in Lot C and Lot D. The high melting rate of ice in Lot A and Lot B at the initial stages of the experiment could be attributed to fish being exposed to high temperatures (over 24°C) during the 1-4 h journey from the fishing ground to the landing beach. After carrying out the necessary preparations, the fish were iced and in the process the ice was placed in close contact with the fish. Heat was transferred from the warm fish to the ice, thus causing it to melt.

Another reason for the high melting rate of ice in Lot A and Lot B is attributed to the size and thickness of the whole fish and fish fillets, as opposed to the fish in Lot C and in Lot D. In spite of the high melting rate, no change in the physical appearance of the fish was noticed. To save the fish from spoilage, it was decided to empty the containers by removing fish and melted water. It would have been in order to leave the fish in the insulated containers untouched and drain the water before re-icing, but this was not practical as the insulated containers had no drainage outlets. This also provided an opportunity for further quality assessment. After the drainage of all the insulated containers, the fish were re-iced in the ratio 1:1 following the same procedure described above. This ratio of icing was adequate since the fish were now chilled.

The fish were kept overnight and on the next day, arrangements were made to proceed to the markets on schedule. Before departure, the fish were inspected to assess the condition of ice and each case the ice was intact.

3.2 Transport of Fish from Kisumu Town to Urban Market in Kenya

The transport used during the period of the experiment included train, bus and GK Lorry. With the exception of the GK Lorry, I had no control whatsoever over public transport. The public transport system is very unreliable and I often wasted a lot of my time waiting for bus transport after purchasing the fish at the landing beach and also when transporting fish from Kisumu town to major markets (see Appendix 3 throughout the country). The journeys from Kisumu Town to the markets took between 2-26 hours. On arrival at the markets, the containers were opened and inspected to assess the general condition of fish and ice before offering the fish for sale.

3.3 Organoleptic Tests

The quality of a food product depends on its nutritive value, safety and taste. There are a number of objective methods used to assess quality. These are sensory evaluation and microbiological, chemical and physical tests. The method applied here was organoleptic testing. In this test the appearance, the smell, the taste and the texture of the fish and fish products are assessed.

3.4 Application

Organoleptic tests were performed by individuals or consumers. Among them were a few selected fisheries personnel working in areas where the fish were sold. Before the removal of fish from each lot to be given to the assessors to take with them for traditional cooking and testing, instructions on how to judge the fish quality was given. In addition, guidelines for quality assessment were also issued to them.

In order to ensure that the quality assessment questionnaire was completed properly by individuals and returned, fish for the tests were given free of charge. In each market six fish traders or individuals were involved in the testing exercise. The results are shown in Tables 1 and 2.

Table 1

Sensory evaluation questionnaire

Experiment on the improved handling of
fresh fish in ice using insulated containers

	Excellent	10
High quality	Extremely good	9
	Very good	8
Limit of high quality	Good	7
	Acceptable	6
Acceptable		5
Limit of acceptability	Fair	4
	Poor	3
Reject	Very poor	2
	Extremely poor	1

Table 2

Sensory evaluation questionnaire

Experiment on the improved handling of
fresh fish in ice using insulated containers

Code	Lot A	Lot B	Lot C	Lot D
Colour: Normal	7	8	9	9
Discoloration				
Odour/flavour: Fresh..................	8	7	9	9
Loss of odour/flavour				
Neutral				
Off-odour/flavour				
Rancid				
Old stale				
Spoiled				
Texture: Firm	9	8	9	9
Soft				
Tough				
Overall quality score	8	7	9	9

From the above results, it is safe to conclude that the fish was in excellent quality by the time it reached the market.

Observation of fish for sale from Lots A,B,C, and D was also made. Temperatures were recorded and the readings were between 0°C and 2°C.

The results of organoleptic assessment showed that there was a great improvement in the wholesomeness of fresh fish in ice. The ice was still intact in each lot after 4-10 days of storage. After the visual assessment the fish traders were invited to view the fish and those who were willing to buy were allowed to do so.

Figure 2 shows final quality assessment.

4. MARKETING

4.1 Marketing of Fish

The marketing of fish caught in the Nyanza Gulf of Lake Victoria is well established. The whole area is served by all-weather roads to major urban markets. Kisumu Town, the capital of Western Kenya, is served by road, rail, steamer services and air. The only shortcoming in the communication system is the poor condition of small link roads from the town's main roads to remote, but productive fishing centres along the lake shore (see Appendix 1).

During the period of the experiment, an extensive marketing survey of the demand for different types of fresh fish on the various markets visited was carried out by talking to fish traders and consumers.

I realized that the attitude of fish traders toward gutted fish was negative apart from at City Market and Mombasa markets (see Appendix 3). I was unable for example to sell gutted Tilapia spp. in Kikomba market in Nairobi, though the fish retailers were happy with the way fish were packed in ice and in the insulated containers. According to the fish retailers interviewed, this negative attitude is the result of the consumers' belief that gutted fish is of low quality. The fish retailers also feel that fish with guts weigh more than gutted fish and there is also fear that by selling fish which do not meet the consumers' preferences, they will be subjected to heavy losses. It is the feeling of the fish traders operating in urban markets, where gutted fish are not popular, that the gutting of fish should be introduced at the fish landing centres throughout the country. This is the only way which will make gutted fish sell in urban markets because it will deny the consumers any other choice.

It is now apparent from the foregoing that there is no single best system for the retail marketing of fish throughout the country.

4.2 Fish Prices

Fish prices are generally not controlled in Kenya and prices of fish caught in the Nyanza Gulf area reach their own levels.

Fish prices at various landing beaches are not uniform as shown in Table 3.

Table 3

Cost prices at landing beaches
(Nyanza Gulf - Lake Victoria)

Beach	Tilapia K Sh/piece	Nile perch K Sh/kg
Dunga	13.00 - 15.00	2.50 - 3.00
Paga	7.00 - 13.00	1.50 - 1.70
Kaloka	8.00 - 14.00	1.50 - 2.20
Luanda Kotieno	12.00 - 13.00	1.70 - 2.00
Uhanya	10.00 - 14.00	1.70 - 1.90
Kendu Bay	9.00 - 14.00	2.00 - 2.50

Notes: Approximate weight - Large T. 1 kg
Large N.P. 20 kg
Medium T. 0-85 kg
Medium N.P. 12 kg
Small T. 0.45 kg
Small N.P. 4 kg

Table 4

Selling prices at various markets
K Sh/kg

Market	Tilapia	Nile perch fillet	Nile perch whole
Kakamega	15.00 - 16.50	9.00 - 10.00	4.00 - 5.00
Kitale	15.00 - 17.00	9.00 - 10.00	4.00 - 5.00
Eldoret	16.00 - 18.50	10.00 - 10.50	5.00 - 6.00
Nakuru	17.00 - 18.00	10.00 - 11.00	5.00 - 7.00
Nairobi	18.00 - 20.00	10.00 - 13.00	5.00 - 8.00
Mombasa	20.00 - 25.00	12.00 - 15.00	6.00 - 8.00

The fish trade in the Nyanza Gulf area is dominated by rich traders from Nairobi and Mombasa who own large trucks. These traders have put off small but rising traders in Kisumu from the fish trade. The rich traders have flooded the markets to the extent that prices of fish are much lower and are not profitable to the small fish trader. Due to these circumstances higher prices could not be achieved as was expected from the improved handling of the fish.

In order to streamline the fish trade, it is my strong feeling that the rich group must not be allowed to buy fish and fish products directly from the fishermen but must wait for small traders from Kisumu to supply them with fish.

5. PROBLEMS ASSOCIATED WITH EXPERIMENTS ON IMPROVED HANDLING OF FISH

5.1 Insulated Containers

It was noted that the lids of the insulated containers expand in high tropical temperatures especially when exposed to the sun.

Lack of drainage holes at the bottom made it difficult to release the meltwater.

Fish were stolen when transported by train. This happened because the insulated containers are not lockable.

Handling of 200-litre insulated containers was cumbersome especially on road transport (buses).

5.2 Handling of Fish

Remoteness of some productive fishing centres from major fish consuming urban centres contribute to the sale of spoiled fish to consumers because of distance and lack of good access roads.

Lack of ice and insulated containers like the ones used during the experiment lead to higher rates of spoilage of fish during transportation.

6. RECOMMENDATIONS

It is recommended that proper handling of fish from the fishing ground to the landing beach be encouraged.

The provision of ice and chillrooms for fish at major fish landing centres along the lake shore is the key to improved fish handling and would reduce post-harvest losses and improve the quality of fish at the market. This would enable fishermen to sell their catch at higher prices.

It is further recommended that fish and fish products should be marketed through the existing fishermen's cooperatives. This would cut down the number of middlemen who are now profiting from the fish business at the expense of the fishermen. The fishermen's cooperatives would sell high value fresh fish to traders operating at the urban markets directly.

Gutting is another desirable procedure to improve the quality of fish at market. It is recommmended that the sooner this is done after catching the better. This should be followed by good washing to lessen contamination of fish by bacteria.

In addition to the recommendations made above, it is also felt that there is a need to extend the period of this experiment for six months. This would enable me to cover wider areas both in the Nyanza Gulf of Lake Victoria and urban markets, something I was unable to accomplish during the period under review.

7. CONCLUSION

This document has stressed the interrelationship between socio-economic factors, technological experiments and an economic evaluation of improved handling of fish using special insulated containers provided by FAO. Many attempts to solve handling of fish in the past have not been successful because the social or economic climate has not been conducive to change. I have tried to discuss to some extent the effect of poor infrastructure, such as water supply, lack of fresh fish preservation facilities (i.e. ice, chilling rooms) and lack of education of the general public, especially those involved in handling and marketing practices. It is also acknowledged that a shortage of well-trained personnel at the extension level has retarded the improvement of handling and marketing of fish in Kenya, as no amount of research can be translated into development in the fishing centres.

It is becoming more important that the country needs to improve handling and processing facilities as the annual catch of some important commercial species of fish continue to increase in Lake Victoria (see Table 5).

Table 5

Lake Victoria (Kenya waters) catch and value for particular species
(t and '000 K Sh)

Species	1982		1983	
	(t)	'000 K Sh	(t)	'000 K Sh
T. esculenta	399	2 107	64	455
T. nilotica	2 581	14 406	2 516	14 061
Other *Tilapia*	1 495	7 338	1 658	6 559
Lates	33 134	60 381	52 377	72 905
Engraulicypris	10 419	14 121	16 444	17 853
Haplochromis	2 546	3 394	612	754
Mormyrus	2 678	3 510	218	417
Protopterus	239	912	108	340
Clarias	2 062	5 599	893	1 980
Bagrus	2 532	5 060	1 243	2 483
Barbus	682	1 822	100	359
Labeo	918	1 889	81	153
Synodontis	232	907	91	329
Schilbe	78	273	22	111
Alestes	2	8	4	12
Small mixed	961	1 673	894	1 548
Totals	60 958	123 400	77 328	120 315

There have been many abortive proposals from local and foreign investors in the past to establish plants in Kisumu Town to serve the whole of the Nyanza Gulf area. In 1973, the Municipal Council of Kisumu established a 5-t flake ice plant with funds from USAID and the Ministry of Tourism through the Department of Fisheries, but because of its endless breakdowns and maintenance problems, the Municipal council of Kisumu now runs its own block-ice plant capable of producing 52 5-kg blocks per 12 h. At the time of writing this report the block-ice plant is out of operation and there is no indication that the ice plant will be operational in the near future.

The time has now come when the earlier proposals to establish ice plants need to be looked into more seriously if the desired goal of supplying fresh fish of high quality to the consumers is to be achieved. A project sponsored by the World Bank through the International Development Association (IDA) is in the process of implementation. The project is designed to establish infrastructure facilities such as communications, ice plants, receiving sheds, chillrooms, etc., to facilitate proper handling and marketing in the Nyanza Gulf of Lake Victoria and distant urban markets, throughout the country.

The information achieved while conducting the experiment and an economic evaluation of improved handling of fish using insulated containers will form the basis for an IDA project. Since this is likely to end up as Government project, there would be a need to encourage more private investors to put up facilities which would supplement Government efforts, apart from introducing some element of efficiency in fish technology development in this area.

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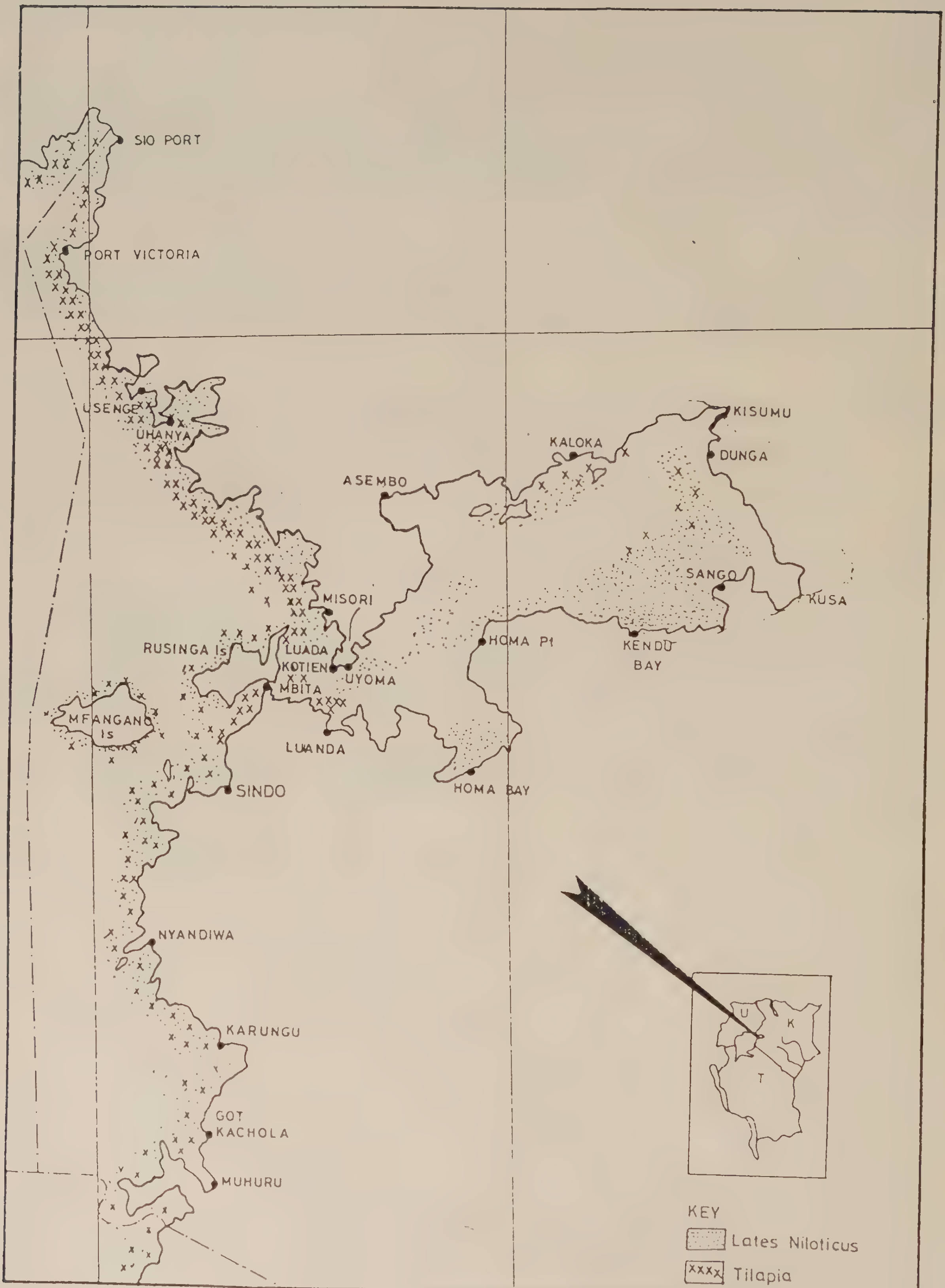
APPENDIX 1

Geographical Distribution of Lates niloticus and Tilapia spp. in the Nyanza Gulf of Lake Victoria


SIO PORT
PORT VICTORIA
USENGE
UHANYA
ASEMBO
KALOKA
KISUMU
DUNGA
SANGO
KUSA
KENDU BAY
HOMA Pt
MISORI
RUSINGA Is
LUADA
KOTIEN
UYOMA
MBITA
MFANGANO Is
LUANDA
SINDO
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NYANDIWA
KARUNGU
GOT KACHOLA
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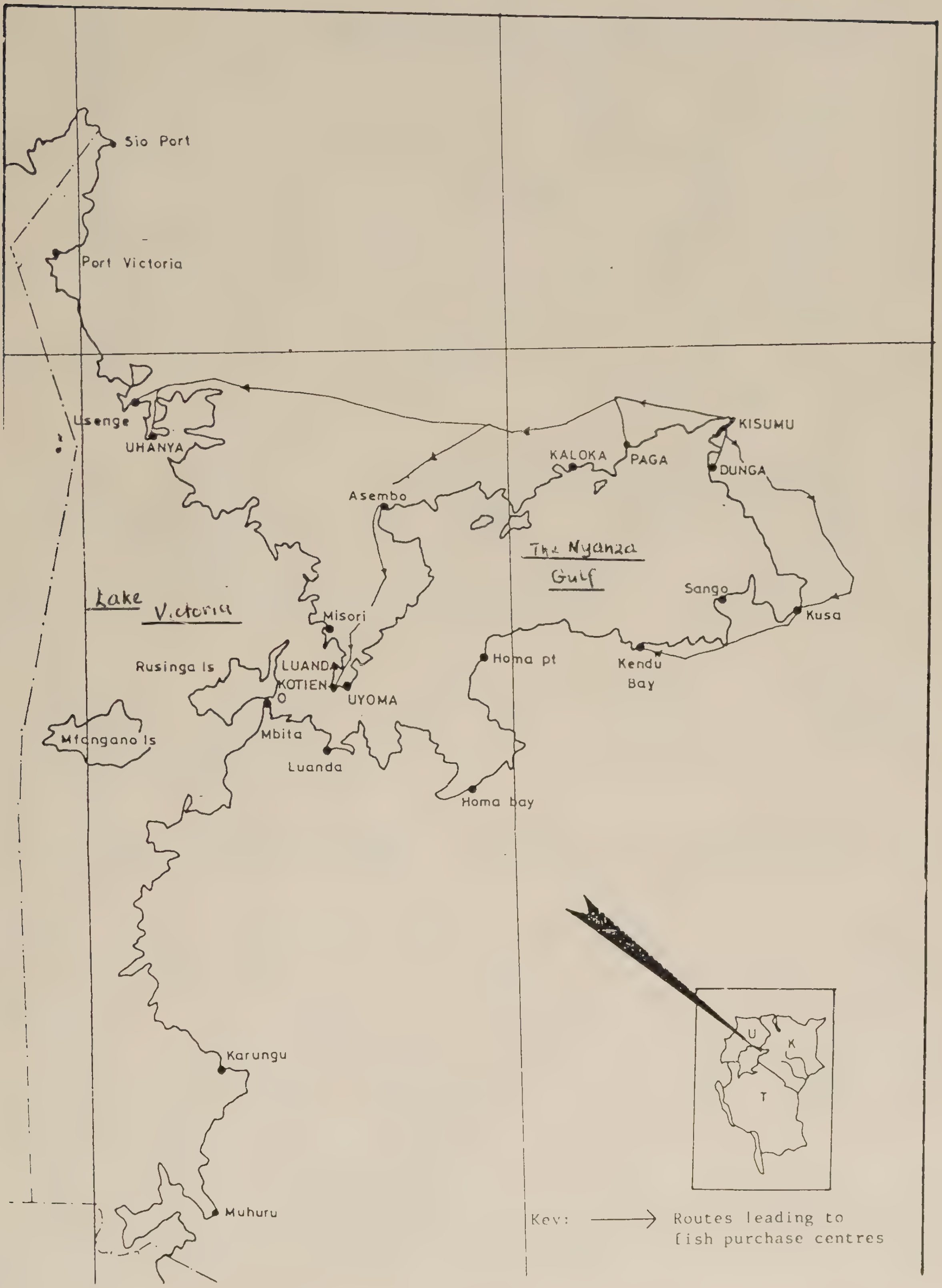
XXXX Tilapia
1:200 000

APPENDIX 2

Developed Beaches and Fish Purchase Centres Along the Gulf of Lake Victoria


Sio Port
Port Victoria
Usenge
UHANYA
KALOKA
PAGA
KISUMU
DUNGA
Asembo
The Nyanza Gulf
Lake Victoria
Sango
Kusa
Misori
Rusinga Is
LUANDA
KOTIENO
UYOMA
Homa pt
Kendu Bay
Mbita
Mfangano Is
Luanda
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K
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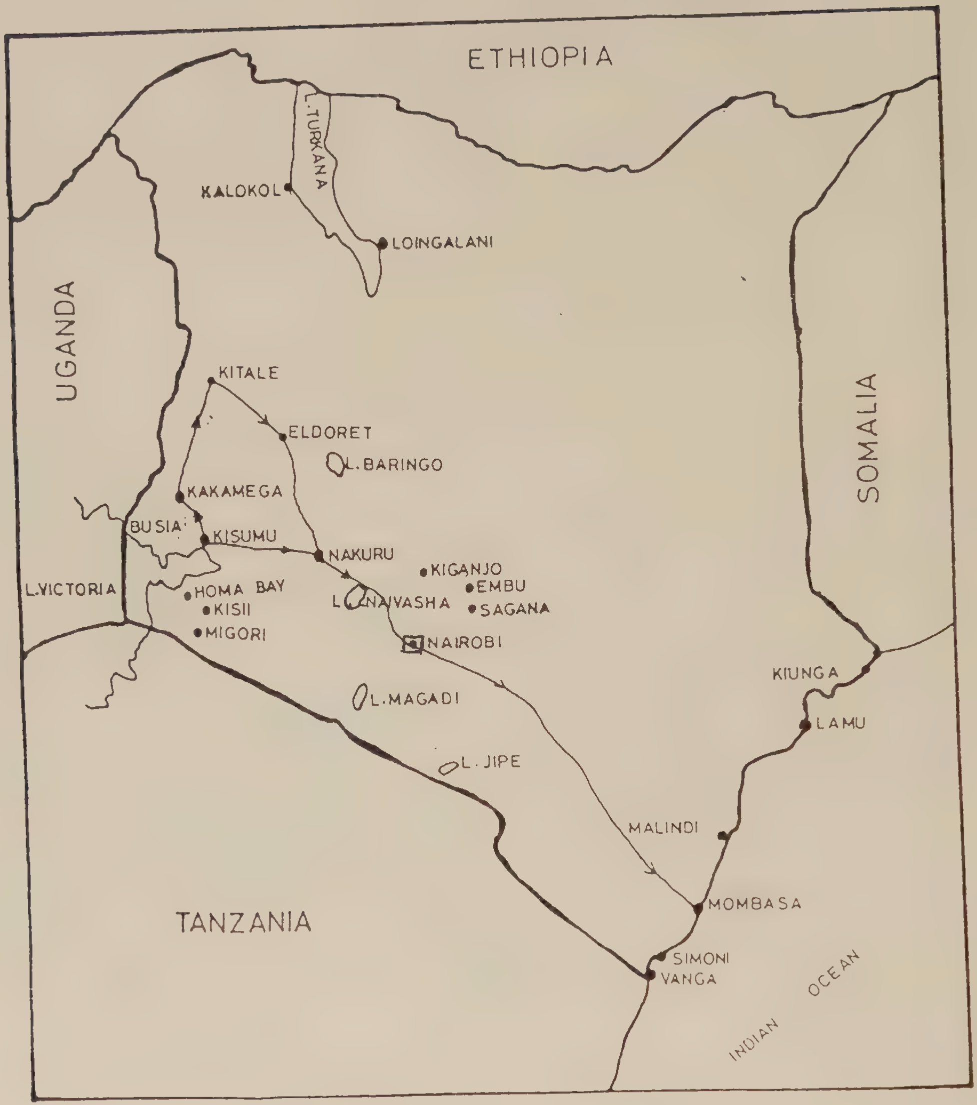
Muhuru
Key: → Routes leading to fish purchase centres

APPENDIX 3

Map Showing Urban Markets Visited


ETHIOPIA
L.TURKANA
KALOKOL
LOINGALANI
UGANDA
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MIGORI
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NAIROBI
KIUNGA
L.MAGADI
LAMU
L. JIPE
MALINDI
MOMBASA
TANZANIA
SIMONI
VANGA
INDIAN OCEAN

Key: ——→ Routes leading to markets visited

RECOVERY OF BYCATCH FROM THE SHRIMP FISHERY BY THE "MOMA TRANSFER" METHOD. A REVIEW

by

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ABSTRACT

A system has been established in Moma in northern Mozambique for landing bycatch fish, which would otherwise have been thrown over board, from the big shrimp freezer trawlers. The bycatch is transferred at sea to small open, 7.6-m long vessels with inboard engines during fishing operations and is landed at Moma. Moma is situated close to the northern part of the fishing grounds with the installations necessary for reception, salting and drying of fish, but with no facilities for reception of the shrimp catches. The paper describes the development of the system.

1. THE BYCATCH SITUATION IN MOZAMBIQUE

The problem of utilization of bycatch fish from shrimp fisheries all over the world consists of two main aspects: (a) the retention and preservation of the bycatch at sea, and (b) the utilization of the bycatch for human consumption. The International Conference on Utilization of Bycatch in Guyana, 1981, gave many suggestions on the second aspect, the utilization. The participants at the Conference recognized that the recovery, handling and preservation on board were the most critical aspects of the bycatch situation, but few viable solutions to the problems were indicated. However, it was agreed that the aim in most countries is the development of methods which do not require high amounts of labour and much space on board; most labour and space is usually taken up by the shrimp fishery.

The Mozambican shrimp fishery is of 10 000-12 000 t per year (Pelgröm and Sulemane, 1982) with an estimated shrimp to bycatch ratio varying between 1:1 and 1:3 (Pelgröm and Sulemane, 1982) depending on season, region and type of fishery. Shrimp to fish ratios of about 1:10 have been reported by one investigator (Steck, 1984). No figures are available for the exact amount of bycatch, but it has been estimated between 20 000 t (Pelgröm and Sulemane, 1982) and 40 000 t (Merritt and Fraser, 1983) per year.

Contrary to the situation in many other countries, there is no problem with the utilization of bycatch for human consumption in Mozambique. The country is in need of cheap sources of protein and almost all fish, independent of species or size, can find a market, either fresh or salted and dried.

The main problem is the preservation method. The Mozambican shrimp fishery is of great importance to the economy of the country, bringing in a major part of its foreign range currency earnings. Most shrimp trawlers are in the size 100-200 t, making voyages of up to three weeks before returning to port in Beira, Quelimane or Angoche. The shrimps are frozen on board soon after catching.

Bycatch retention has a high priority in the state-owned part of the shrimp industry, but the methods have to be restricted to those which do not limit the shrimp catches or the shrimp carrying capacity to any substantial degree. Considerable efforts have been made to develop feasible technical and economic solutions to the problems.

2. A REVIEW OF PROPOSED BYCATCH RECOVERY METHODS

In March/April 1983 the consultants Merritt and Fraser from the Canadian Institute of Fisheries Technology and the Canadian Fishery Consultants Limited visited Mozambique in order to study the situation and to make a survey of possible solutions to the problems. In the final report to the Mozambican Government (Merritt and Fraser, 1983) several possible solutions are discussed in relation to economics.

Recovery methods may be divided into two main categories: preservation on board until the end of the voyage, and repeated transfer of the catch to the shore during the voyage.

Freezing of the entire bycatch on board will inevitably lead to a reduced shrimp carrying capacity, reduced annual shrimp catches per boat and thus be costly.

Storage of the bycatch on board in refrigerated sea water (RSW) or ice will occupy space used for storage of shrimps or fuel. Besides, it has been shown by Mocking and Machava (1985) that the bycatch may only be stored in ice on board for a maximum of seven days, if it is to be used later for salting and drying. Application of this method would require either a severe cut in the length of fishing voyages or a transfer of catch to shore before the end of the voyage.

Bulk salting on board is the simple technology method requiring the least space and labour. However, it has been shown by Jensen and Machava (1985) that fish weighing more than 35 g from the Mozambican shrimp fishery cannot be preserved by bulk salting of the whole fish alone. Preservation of the entire bycatch by salting would require a high amount of labour for grading and eviscerating large quantities of small fish or the use of refrigeration.

Merritt and Fraser (1983) proposed the reconstruction of a bigger, older vessel for collection of the bycatch at sea, using two smaller open rafts for the transfer operations. The costs were estimated at Mt. 6.50/kg (at approximately Mt. 40 to US$ 1.00) for third grade fish.

The construction of a new collector vessel with RSW installations on board for transfer of bycatch at sea by pumping, serving seven catching vessels, would give an estimated bycatch cost of Mt. 8.40/kg of third grade fish. When built to serve 16 catcher vessels the cost could be lowered to Mt. 4.80/kg of third grade fish, but both cases would require high investment in new boats and equipment.

Transfer of the bycatch to smaller open boats coming out from fishing ports and villages along the coast close to the fishing grounds was also studied by Merritt and Fraser. They estimated that the cost of this method could be as low as Mt. 1.50/kg of third grade fish. This solution, which is clearly the cheapest, hardly involves any major investments, and utilizes boats constructed in Mozambique. The most important drawbacks of the system are the limited range of the collector vessels and the sensitivity to weather conditions.

This system is actually in use in Moma, a fishing town close to the northern part of the shrimp fishing grounds, and it has been called the "Moma transfer" method.

3. THE MOMA TRANSFER METHOD

3.1 Background

Until a few years ago most of the bycatch was discarded at sea. Shrimp trawlers might eventually preserve the fish from the last day or two of fishing before entering the base port.

Apart from this, smaller quantities might be landed during voyages. The area close to the island of Chiloane is considered dangerous for navigation at night, and trawlers would anchor at the island beaches during the night, and at the same time unload bycatch for salting and drying.

Furthermore, it has been common practice for smaller rafts and canoes to approach trawlers fishing close to shore and receive bycatch in exchange for fresh fruit, manioc, locally-produced liquor or any kind of locally-produced food. This fish would be used for bait or for salting and drying.

This tradition led to the idea of organizing the collection of bycatch at sea on a bigger scale.

3.2 The Moma Fisheries Cooperative

In 1982 bycatch transfer at sea was started by UDPPE (the Direction Unit of the Small-Scale Fisheries of the Secretariate of State for Fisheries, Mozambique) from Moma. Moma is situated at the North of the shrimp fishing grounds (see Figure 1). It already had the infrastructure necessary to start bycatch collection consisting of a fisheries cooperative (combinado pesquero) dealing with fishing, catch reception from private fishermen, salting and drying of fish, port facilities, cold store and access roads to major towns in the province.

Moma is situated on a river mouth and access to the harbour from the sea goes past a sand bank. Smaller vessels can pass the bank at any time, but shrimp trawlers and bigger ships can pass only at high tide.

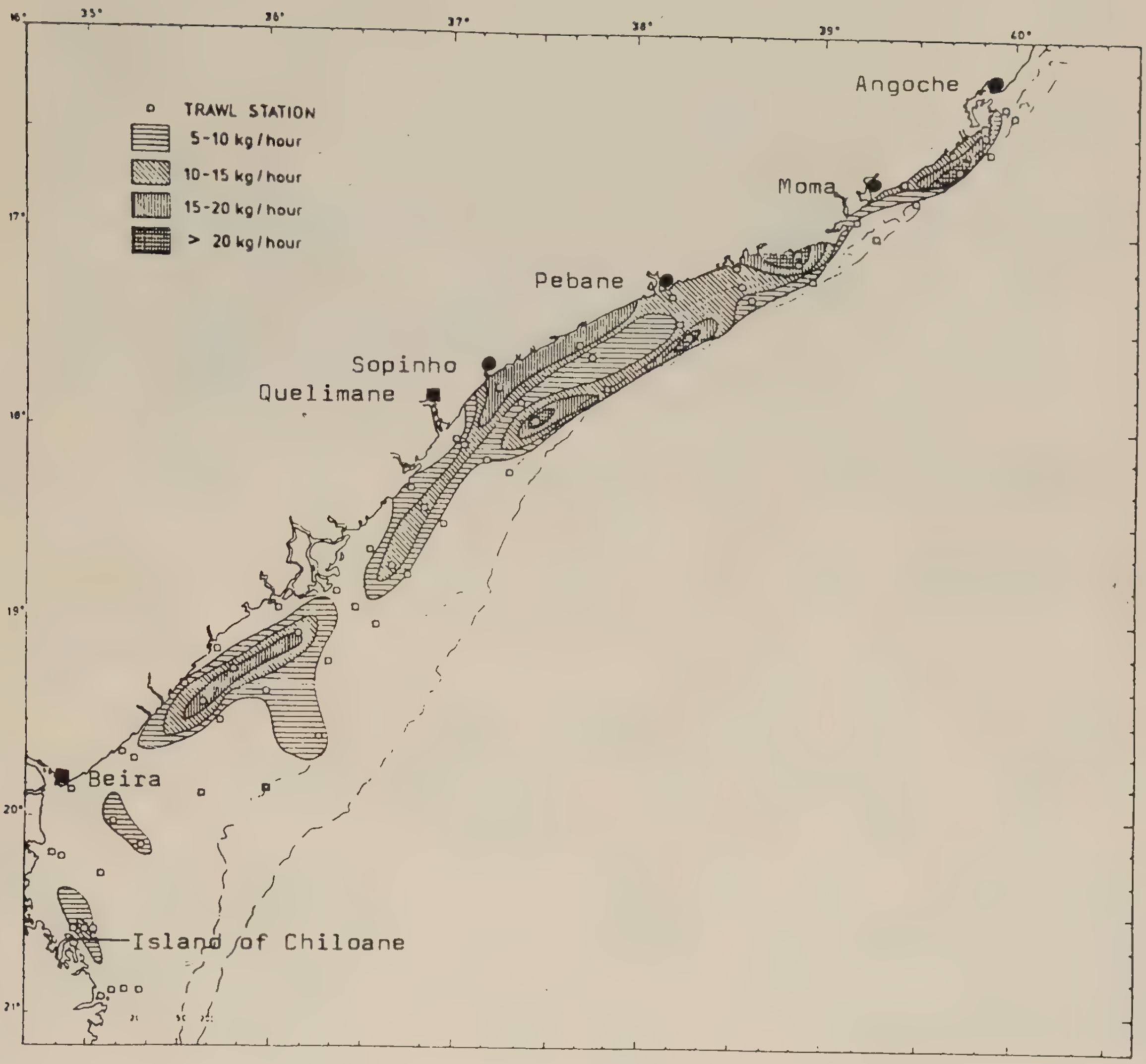
35°
36°
37°
38°
39°
40°
16°
17°
18°
19°
20°
21°
TRAWL STATION
5-10 kg/hour
10-15 kg/hour
15-20 kg/hour
> 20 kg/hour
Angoche
Moma
Pebane
Sopinho
Quelimane
Beira
Island of Chiloane

Figure 1 Trawl survey by the Fisheries Investigation Service (SIP) of the Institute for Fisheries Research (IIP) on the Sofala Bank, July-August 1979. Map of stations and estimated shrimp density strata (Ulltang, unpubl.)

If the trawlers want to go in to Moma to unload bycatch they have to spend steaming time, await high tide in order to go in, unload, and await the next high tide in order to get out again. A whole day of fishing is lost in this way. It is the same with a number of other smaller ports along the coast.

3.3 Operation of the Moma Transfer Method

In the Moma transfer method the trawler makes radio contact with the port when it gets close to the area. A small NP2-type open boat is sent out to meet the trawler.

The NP2 is a 7.60-m long by 2.40-m broad wooden vessel with an inboard engine (see Figure 2). It is used by the fisheries cooperative for gillnetting, beach seining and some longline fishery. When used as a collector vessel it will usually have four men on board.

The collector vessel approaches the catcher vessel while this is still fishing, positioning itself in front of the trawler and by lowering its speed until it is positioned on the leeward side of the trawler, can be tied to it.

It is important that the collector vessel is low enough to pass below the outrigger holding the trawl.

While trawling continue, the bycatch fish from the same day is transferred to the collector vessel in boxes of 20-25 kg. The boxes are emptied into the hold and are returned to the trawler.

The first NP2 boat was able to carry 1-1.5 t of bycatch (Donato, pers. comm.). Later the number of boats used in the Moma transfer was increased to three, and the construction of the two new boats was made broader to increase the carrying capacity. The latest built boats can carry up to 5 t of fish (Anlawe, pers. comm.) and can serve several trawlers in the area on each trip out from Moma. The collector vessel can receive between 1 500 and 2 000 kg of fish (Anlawe, pers. comm.) from each trawler. Each transfer takes between 15 and 30 minutes (Merritt and Fraser, 1983). A maximum of two trips may be made per day if required (Anlawe, pers. comm.).

The collector vessels are only used for fishing when no shrimp trawlers are reported present in the area close to their action radius.

3.4 Handling and Processing of Bycatch in the Moma Transfer

Virtually all bycatch is now retained on board the State-owned part of the shrimp fleet. Selection of the fish into three categories according to commercial value (species and size) takes place on board. This grading is not concerned with freshness.

First grade fish are frozen on board; second and third grade fish are kept on deck, usually in a shady place, and kept moist until collected. No chilling is applied. When fishing far from a collection point or on days with bad weather all bycatch fish is frozen and stored in master cartons of 20 kg. However, this has to be carried out very carefully in order to prevent endangering the shrimp quality as few trawlers have sufficient freezing capacity to deal with both shrimps and high quantities of bycatch at the same time. If the freezer storage room is filled with fish during the voyage frozen fish may also be transferred to the collector vessel, although this does not happen often.

Fresh fish quality may suffer to some extent from the storage time on deck from catch to collection and during transport to the collection point. However, the system is exclusively used for fish caught the same day, which limits the quality losses.

Good quality fresh fish and frozen fish is used for fresh consumption in the region, and lower quality fresh fish is used for salting and sun drying, being processed on the day of reception.

4. RESULTS AND PERSPECTIVES

Transfer of bycatch has been expanding since the start in 1982. Table 1 shows the amounts transferred from August 1982 to April 1984. They vary widely during the year, mainly due to variations in weather conditions, and to the choice of fishing grounds by the trawlers. Although there is quite a difference between the 173.3 t of fish landed through the Moma transfer method in 1983 to the estimated potential bycatch recovery of approximately 20 000 t/year, the first experimental introduction of the method in Moma has now proved its usefulness and the system will be expanded to other areas along the coast.

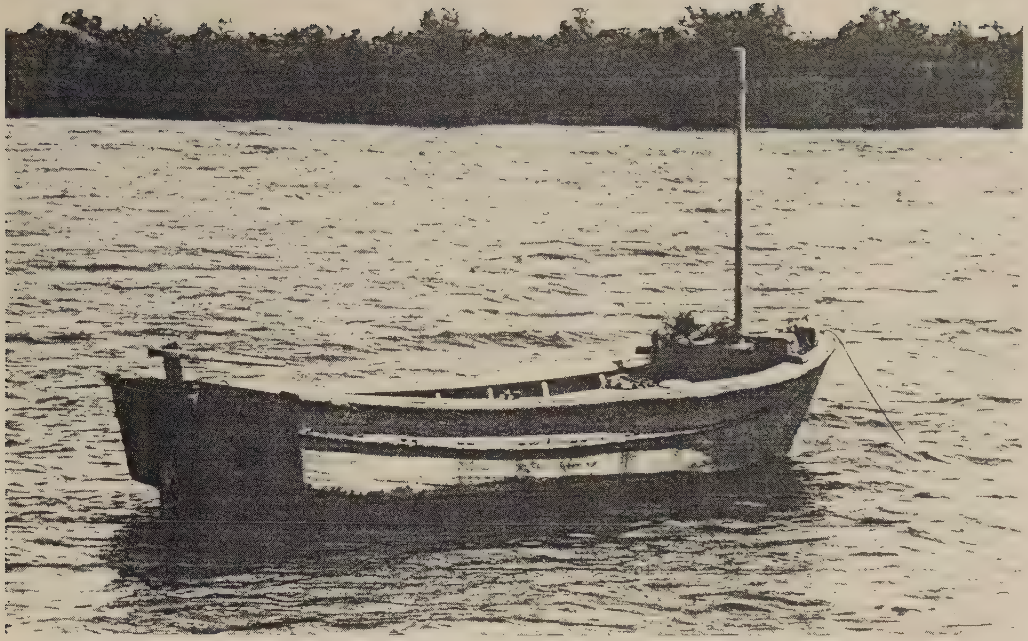

Figure 2 NP2-type fishing vessel, used during the initial phase of the Moma transfer

Table 1

Bycatch fish transferred by the Moma transfer from
August 1982 to April 1984 (in tons)

	1982	1983	1984
January		0.4	8.5
February		6.1	1.7
March		5.9	15.3
April		2.5	3.0
May		53.1	
June		24.2	
July		4.8	
August	4.3	22.5	
September	3.0	11.4	
October	3.9	20.3	
November	15.8	11.0	
December	8.7	10.1	
Total	35.9	173.3	

Source: UDPPE (Donato, pers. comm.)

Merritt and Fraser (1983) estimated that a maximum of 50% of the total bycatch from the Mozambican waters might be landed by this method when the system was fully introduced. The main limiting factors are sensitivity to weather conditions, the limited range for the small boats, and lack of chilling on board during transport. Other retention methods, for instance collection at sea by bigger collector vessels or, to a limited extent, freezing on board, might cope with the remaining 50%.

The method is given high priority by the Secretariat of State for Fisheries in the development of the fisheries sector. It has recently been started up from Quelimane with two boats, and its introduction is planned in Sopinho and Pebane, at the centre of the most important shrimp fishing area, covering in this way a larger part of the coastline.

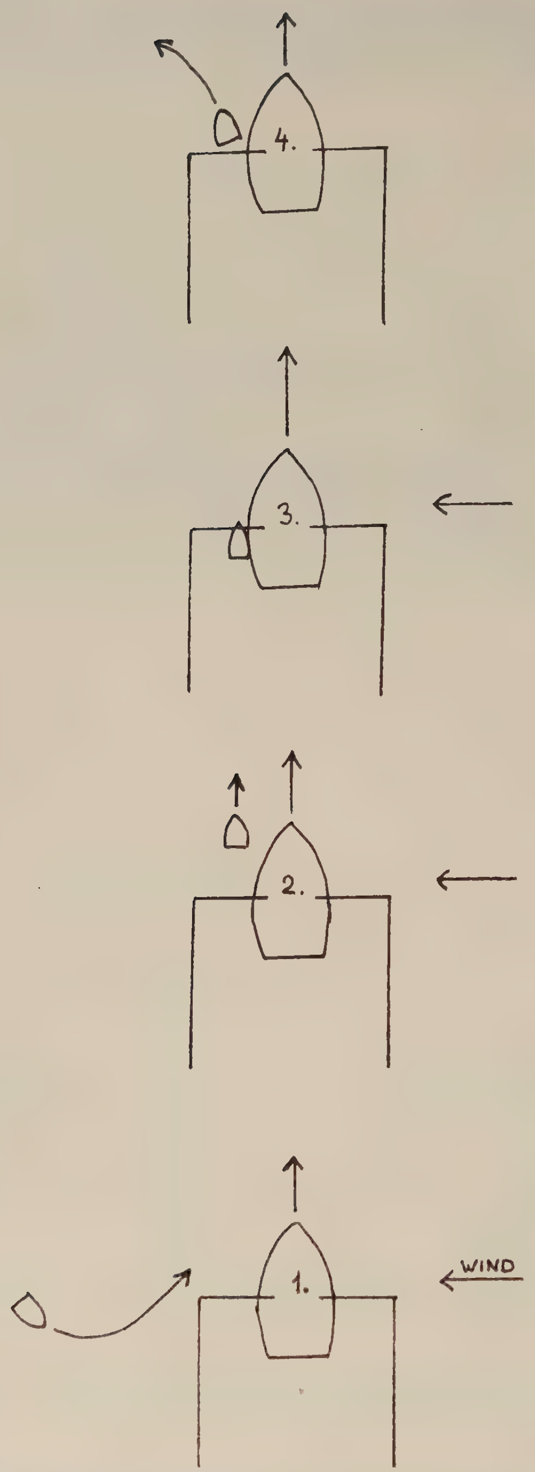

Figure 3 Diagram of the positions of the collector vessel during the Moma transfer. 1 and 2: approach; 3: transfer; 4: separation

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STORAGE LIFE ON ICE OF THE BYCATCH FROM THE SHRIMP FISHERY

by

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ABSTRACT

As part of a general effort to utilize the bycatch for human consumption in Mozambique through the development of adequate handling systems, trials were carried out to determine the shelf life of the bycatch on ice. Two common species were selected: Corvina (Otholithes rubes) and Ocar (Thryssa vitirostris). The storage life on ice was found to be eight days when destined for salting and drying, and five days when intended for fresh consumption. Considering the time needed to reach the consumer or the processing plant, it is concluded that the maximum storage time in ice on board is four days for fresh consumption and seven days for salting and drying. This means that the iced bycatch must be brought ashore before the end of the fishing trip for shrimps which may take up to three weeks.

1. INTRODUCTION

One of the Mozambican options to resolve domestic fish shortages is to maximize the use of the shrimp bycatch, which until a few years ago was almost totally discarded at sea. In a contribution to the Technical Consultation on Shrimp Bycatch Utilization, held in Georgetown in 1981 on the developments in Mozambique, Pelgröm and Sulemane (1982) estimated the shrimp bycatch at 20 000 t/year. The retention of this would increase the registered landings of marine fish by 50%. Merritt and Fraser (1983) mentioned an amount of 40 000 t/year, and described the bycatch fish as small, often immature individuals, belonging to demersal and pelagic species.

The most important problem is how to retain and preserve the bycatch. In 1983 Merritt and Fraser studied the retention of the shrimp bycatch in Mozambique; they found that in the majority of cases preservation of fish had to be achieved by chilling in ice or in refrigerated sea water (RSW).

The objective of the present study is to establish the shelf life of the shrimp bycatch after chilling it as quickly as possible with ice. The shelf life is established by sensory tests. An investigation was made of some chemical, physical and microbiological parameters as indicators of acceptability.

2. MATERIALS AND METHODS

The Mozambican shallow-water shrimp resources are predominantly situated on the Sofala Bank in central and northern Mozambique. The selection of the species for the experiments is based on their abundance in catches, as well as on their commercial value. Cristo (1983) compiled information about the bycatch composition on the Sofala Bank. A summary of the results is presented in Table 1. The composition of the bycatch varies with the specific area, season and percentage of shrimp in the catch. To facilitate the experiments in Maputo it was necessary to introduce a third criterion: the appearance of these species in the Bay of Maputo. Timochin (pers. comm.) stated that the, following species are frequently present in the shrimp bycatch from the Bay of Maputo: Corvina, Macujana, Patana, Peixe Pedra (lined silver grunt, Pomadasys hasta) and Ocar.

2.1 Methods of Handling and Storage

The fish used in the four storage experiments was caught in the Bay of Maputo on one-day trips by shrimp trawlers of the "Combinado Pesqueiro" of Sulpesca. The experiments took place in the winter period: May-July 1983. The ambient temperature during collection was $21^{\circ}-24^{\circ}C$. Fish of uniform size from each trip was selected from the same haul (Table 2). Only Corvina and Ocar

Table 1

Bycatch composition on the Sofala Bank
(percentages on stated weight)

Demersals: 52-93%		
Scianidae	Corvina	Tigertooth croaker/ *Otolithes ruber*
	Macujana	Boulengers croaker/ *Johnius belengerii*
Synodontidae	Peixe Banana	Brushtooth lizardfish/ *Saurida undosquamis*
Mullidae	Salmonete spp.	Among others: Yellowstriped goatfish/ *Upeneus vittatus*
Pomadasyidae	Roncador	Smallspotted grunt/ *Pomadasys operculare*
Trichiuridae	Peixe Espada	Frostfish/ *Lepidopus caudatus*
Pelagics: 4-48%		
Clupeidae	Sardinha spp.	
Engraulidae	Ocar	Malabar thryssa/ *Thryssa vitirostris*
	Anchova spp.	
Leiognathidae	Patana	Spotted sicklefish/ *Leiognathus equilus*

Table 2

Sample information

	Corvina	Ocar
Commercial grade	2nd	3rd
No. of collections	3	1
Period of sampling	May-June	July
Average length	15 cm	12 cm
Average weight	103 g	56 g

appeared in sufficient quantities to carry out the storage experiments. The hauling time was 4 hours; the temperature of the fish on catching, 18°-21°C. The fish was selected and washed immediatley after catching. Within 30-60 minutes the selected samples of whole fish were placed in ice in insulated boxes. The fish was chilled to 0°-2°C within 2-3 hours. After unloading on the day of the catch, the ice was renewed and the boxes were placed in a cold store operating at between -2°C and +2°C. New ice was added during the storage period when necessary.

2.2 Quality Assessment

2.2.1 Organoleptic evaluation

Appearance and odour of raw fish, and appearance, odour, texture and taste of cooked fish were evaluated by a panel of six trained persons using a scoring system rated from 10 to 0. The highest score 10 is the optimum quality, 10 to 6 is good, 6 to 4 is acceptable, and 4 is the limit for human consumption. Minor changes took place in the panel during the experiments, and it was not always possible to maintain a high training level of the participants.

The cooked fish was prepared as follows:

- scales, viscera and gills were removed; the head was kept on;
- cooking was carried out in boiling water with 2% salt for 20 minutes.

2.2.2 Chemical analysis

The fish was analysed for total volatile bases (TVB) (Billon *et al.*, 1980), peroxides (oxidation by potassium periodate), pH (Lima dos Santos, 1981) and total bacterial count (of a transversal section; incubation at 37°C) on the day after the catch, and later once when close to the limit of acceptability in order to give an indication of the development of these parameters.

Further, the chemical composition of the edible flesh was analysed: moisture (105°C), proteins (by Kjeldahl), fat (by Sochlet) and ash (550°C).

All the analyses were carried out by the Laboratory of Food Hygiene and Water of the Ministry of Health.

3. RESULTS

3.1 Chemical Composition

Results are given in Table 3.

Table 3

Chemical composition average results %

	Corvina	Ocar
Moisture	77.9	76.6
Proteins	18.6	18.5
Fat	2.3	3.7
Ash	1.3	2.6

3.2 Organoleptic Evaluation

3.2.1 Storage experiments

The results of the storage experiments are shown in Figures 1-3. The analysis of variance was inconclusive because of low and varying numbers of judges in the quality assessments.

Results are summarized in Table 4. The Ministry of Health of Mozambique, considers that fish on sale needs to have a quality level of good (Saúde, 1983), corresponding to a score of 6 or higher. Fish with a score of 4 or higher may be used for salting and drying. Fish with scores below 4 is rejected for human consumption. For this reason Table 4 does not refer only to the total storage time (quality $\geq$ 4), but also includes the storage time before the quality reaches the limit of 6 for sale for fresh consumption.

Table 4

Storage time in days in ice before reaching the quality limits of 6 and 4, respectively

	Sampling date	Corvina		Ocar	
		raw	cooked	raw	cooked
Quality evaluation (first day after catch)	24.5.83	7.6	8.4		
	8.6.83	8.5	8.5		
	22.6.83	9.0	8.4		
	27.7.83			8.3	8.3
Storage time for fresh consumption (days)	24.5.83	3.0	7.0		
	8.6.83	8.0	7.0		
	22.6.83	6.0	5.0		
	27.7.83			7.0	7.0
Total storage life for human consumption (days)	24.5.83	8.0	9.0		
	8.6.83	11.0	11.0		
	22.6.83	9.0	10.0		
	27.7.83			13.0	13.0

3.2.2 Chemical, physical and microbiological evaluation

The results are presented in Table 5. Only total bacterial count and pH tend to give clear differences. The acceptability limit appears principally to be determined by autolysis and microbiological deterioration; the fat content is too low to cause significant formation of rancidity.

To establish acceptability limits it is necessary to continue the experiments by following the development of TVB, bacterial count and pH during the whole preservation period. It is unnecessary to study the development of peroxides.

Table 5

Chemical, physical and microbiological evaluation

Species	Sampling date	Days after catch	TVB mg NH_3/100 g	Peroxides[a/] meq O_2/kg	pH	Total bacterial count	Remarks
Corvina	24.5.83	1	17.1	9	6.99[b/]	7.6×10^3	
		9	18.7	6		1.7×10^6	Rejected
		13			7.15		Rejected
22.6.83	1	20.0		–	6.80	2.6×10^3	
		15	67.3	6	7.90	1.2×10^5	Rejected
Ocar	27.7.83	1	13.3	–	–	9.4×10^3	
		16	16.3	–	–	2.6×10^3	Rejected

a/ The limit of analysis is 6 meq O_2/kg

b/ Measured on the second day after catching

4. DISCUSSION AND CONCLUSIONS

The practical question is: "How long can the bycatch be stored on board, in ice or in RSW, before being landed?" The answer depends on the destination of the product. Fish to be consumed immediately or to be frozen needs a quality not below 6 (see Section 3.2.1). The quality limit for fish to be salted and dried is 4.

The storage life of the entire bycatch must be determined by the most vulnerable species. Based on the results presented in Table 4, the bycatch may be stored for five days in ice when intended for fresh consumption and eight days in ice when destined for salting and drying. It is estimated that RSW storage will give similar or only slightly better results.

However, the storage life has to be calculated with reference to the time needed to reach the consumer or the processing plant (Table 6). The time for distribution of fresh fish to the shops and other selling points depends on location. In harbour cities, like Maputo, Beira and Quelimane, and their suburbs, fish can reach the consumer within one day after landing. In the case of the "Combinado Pesqueiro" of Moma, where the shrimp bycatch has to be sold in the cities of Nampula and Nacala after transport over distances of 300-600 km, one has to allow two days for distribution.

Table 6

Storage and distribution times

	Fresh	Frozen	Dried
Quality limit	6	6	4
Maximum storage life on ice (days)	5	5	8
Distribution time (days)	1-2	0.5	1
Storage time on board (days)	3-4	4.5	7

Freezing can take place immediately after landing; salting or drying within one day.

However it is viewed, for fresh consumption or for salting and drying, the bycatch stored in ice or in RSW has to be landed before the end of a fishing trip of 20-22 days. The following alternatives for the bycatch preservation in ice or in RSW are therefore possible:

(a) to land the bycatch in harbours close to the fishing areas, after keeping a maximum of 4 or 7 days on board, storing in ice or in RSW. In the case of 7 days storage the fish has to be salted and dried;

(b) to transfer the fish to transport vessels, as it is done in the "Moma transfer" described by Merritt and Fraser (1983) and Jensen (1985). Small, open boats of the "Combinado Pesqueiro" of Moma collect the bycatch from the shrimp vessels at sea at a distance of 4-5 hours sailing time. In this manner the fish has to be collected after keeping a maximum of 3 or 7 days on board, the fish for fresh consumption being transported to Nampula or Nacala;

(c) another method is to transfer the fish to bigger transport vessels which accompany the shrimp trawlers, and then to transport the fish to the harbours during the trip. This method is extensively described by Merritt and Fraser (1983). The same time limits have to be observed as mentioned in alternative (a).

The fish caught during the last 4-7 days of the fishing voyage, and stored in ice or in RSW, may stay on board the shrimp vessel.

The experiments described here are very limited and need extending to include different species, different seasons, and practical chilling and refrigeration procedures on board.

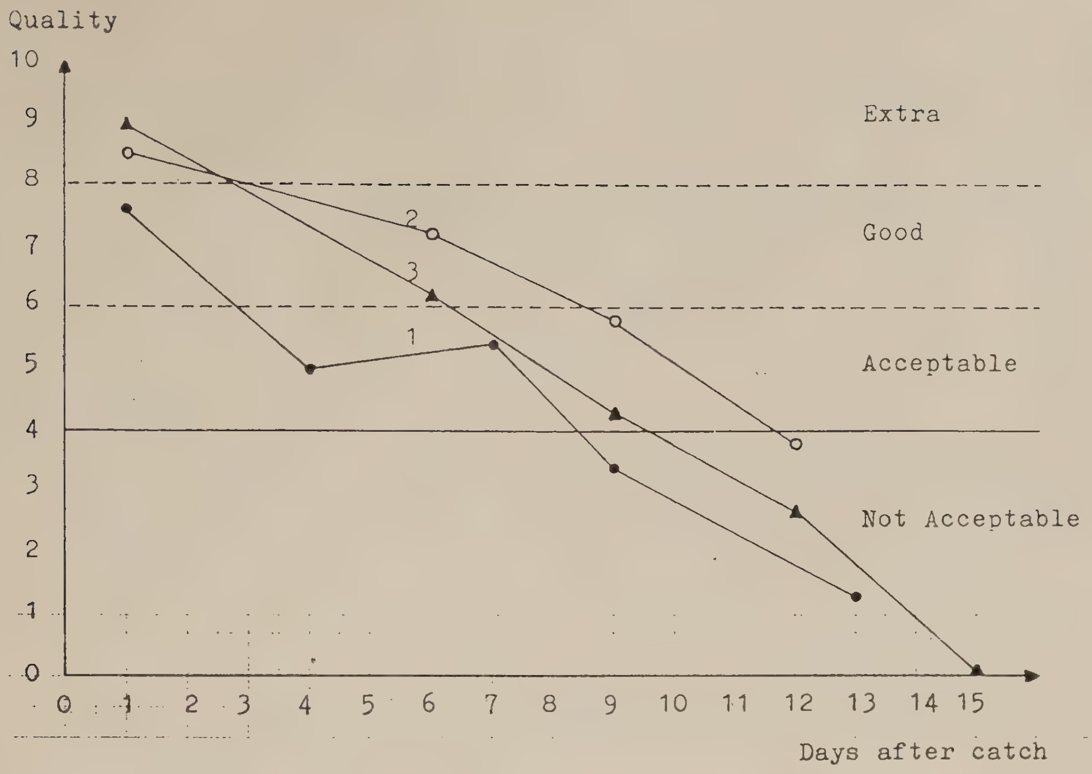

Figure 1 Sensory evaluation of raw Corvina:
-●- Sample of 24.5.83 (1); -○- of 8.6.83 (2); -▲- of 22.6.83 (3)
95% confidence interval: between ± 0.6 and ± 0.7 depending on the number of judges in the assessment

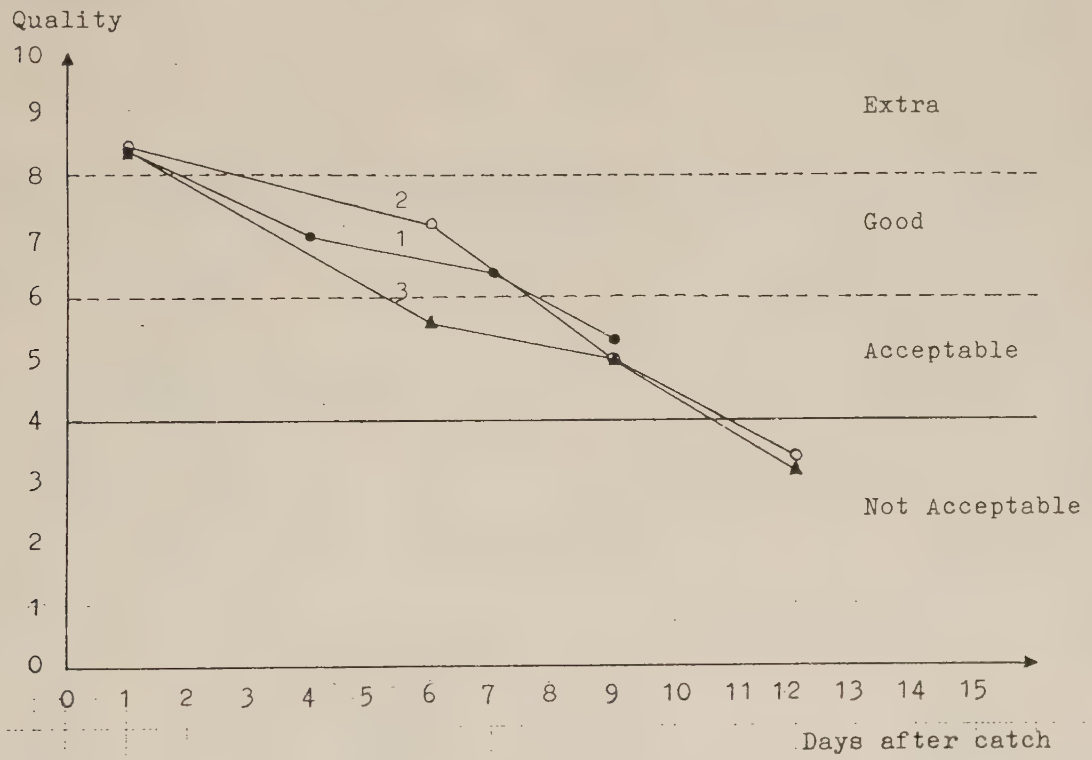

Figure 2 Sensory evaluation of cooked Corvina:
-●- Sample of 24.5.83 (1): -○- of 8.6.83 (2); -▲- of 22.6.83 (3).
95% confidence interval: between ± 0.9 and ± 1.1 depending on the number of participants in the assessment

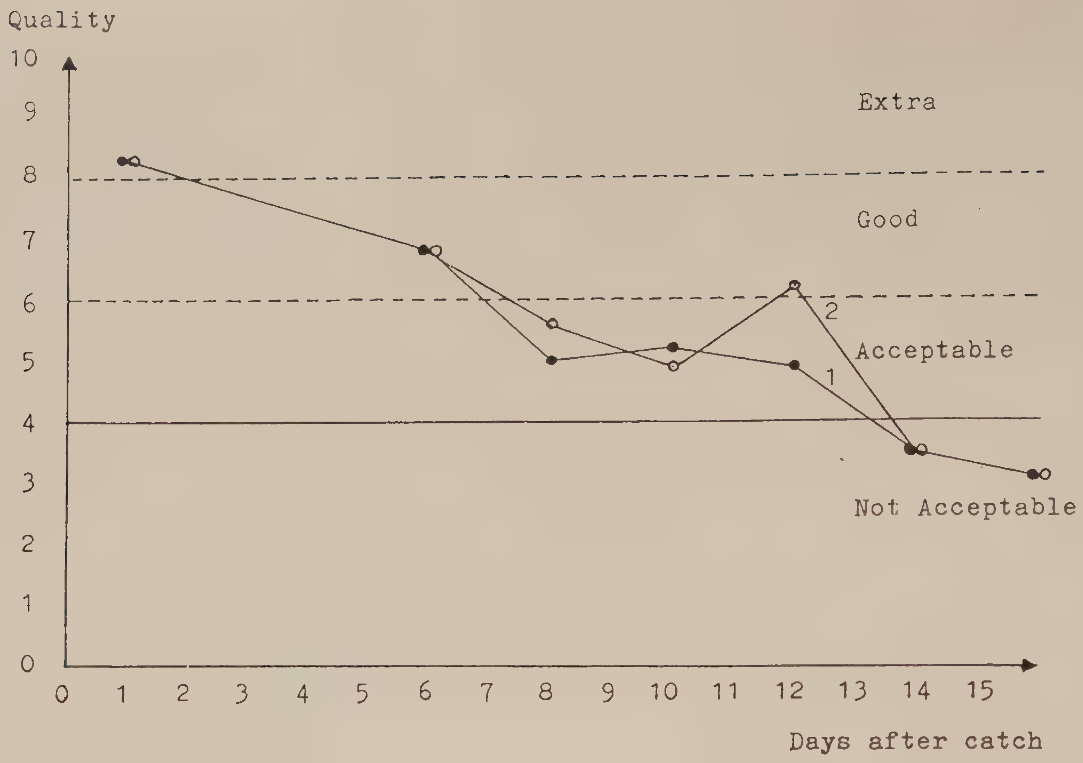

Figure 3 Sensory evaluation of Ocar:
-●- Sample of 27.7.83, raw (1); -○- of 27.7.83, cooked (2)
95% confidence interval: between ± 0.8 and ± 1.1 depending on the number of participants in the assessment

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SALTING ON BOARD OF BY-CATCH FROM THE SHRIMP FISHERY

by

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ABSTRACT

As part of a general effort to retain by-catch fish for human consumption, and following suggestions from previous investigators in the area, trials were made to preserve the by-catch on board by salting. At present a major part of the by-catch used for consumption is salted and dried on shore. Bulk salting of whole small fish on board might require less equipment, space and labour than freezing or ice packing. The experiments showed that a high percentage of the fish above 35 g undergoes rapid gas formation in the belly cavity, leading to the deterioration of the whole batch within a few days. It is concluded that fish above 35 g must be eviscerated or split before salting if additional chilling is not applied. As sufficient labour is not available on board the Mozambican shrimp trawlers for sorting and gutting of large quantities of small fish, salting is considered unsuitable as the only method of conservation on board.

1. INTRODUCTION

By-catch from the shrimp fishery represents a large and underutilized resource. In Mozambique the total amount of by-catch has been estimated to be between 20 000 t (Pelgrøm and Sulemane, 1982) and 40 000 t (Merritt and Fraser, 1983) per year. Although an increasing part of it is being landed for human consumption, problems in handling and storage of the by-catch on board are still leading to a large quantity being discarded at sea. The problems have been studied by various investigators. Merritt and Fraser (1983) made a survey of different retention methods, including storage on board in ice or refrigerated sea water (RSW), freezing on board and collection of by-catch at sea by small boats, as in Moma Transfer, or by bigger collector vessels. The work was followed up by Mocking and Machava, 1985 who studied ice packing of bycatch, and Jensen (1985) who described recent developments in Moma Transfer.

Each of these solutions has, however, some disadvantages. Preservation methods on board require space and labour and tend to limit the shrimp carrying capacity or the length of the voyage. Transfer at sea as in Moma Transfer has a limited range, and may only deal with 50% of the total by-catch (Merritt and Fraser, 1983).

As a major part of the landed by-catch is used for salting and drying, salting on board might be one solution. Salting on board was proposed by Merritt and Fraser (1983) and Watanabe (1983) as a preservation method. Also, Young (1982) mentions that partial processing on board may be a solution to the handling and storage problems of the by-catch.

Salting has the advantage that it does not require complicated mechanical equipment, insulated storage rooms or tanks. Salt is easier to store than ice, though it may cause some corrosion problems on board the steel vessels, and salted fish occupies less space than frozen fish or fish stored in ice or RSW.

The conditions for the introduction of salting on board are:

- that labour requirements should be kept low; i.e., that the fish should be salted without previous evisceration by hand, and that it should be salted in bulk;
- that space requirements should be kept low; i.e., that it should be salted in fixed tanks of any shape on board;

- that the fish should be preserved in this way for at least three weeks (the length of the voyages) without further attention.

The reason is that the crew is already fully occupied by the shrimp fishery and there is usually no space available for accommodation of additional crew members.

The present work examines whether these three conditions can be met. So as to use the existing laboratory facilities in Maputo the experiments were made with by-catch from the shrimp fishery in the Bay of Maputo, although the main shrimp fishing area is situated further north on the Sofala Bank.

2. EXPERIMENTAL PART

The experimental work was divided into two parts:

(a) a pilot experiment to salt the by-catch on board showing the type of problems to be met;

(b) a salting experiment on board, to determine size limits for fish which can be salted whole.

2.1 Pilot Experiment to Salt the By-catch

2.1.1 Materials and methods

The shrimp were caught by a commercial shrimp trawler belonging to SULPESCA, Maputo. Fish for the experiment were sampled from the first haul.

Experimental data:

Date of initiation of the experiment:	15.02.1984
Trawling time:	3 hours, 1 min.
Water temperature:	29°C
Fish temperature:	29°C
Air temperature:	31°C

Twenty kilogrammes of third grade fish (referring to commercial quality of lowest value) were separated from the catch and mixed thoroughly with 10 kg of solid salt in a plastic container. Salting was finished 90 min after catching. When no visible quantities of brine had formed 4 h after salting, 3 litres of sea water were added to the container, which was then agitated to facilitate brine formation. A lid kept the fish below the brine surface. After addition of sea water the container still contained a 50% surplus of salt.

After being unloaded at the end of the day the container was stored at ambient temperature at the Institute for Fisheries Research. The salted fish were inspected visually at frequent intervals. At the end of the experiment, 17 days after the start, the salted fish were weighed and the pH of the brine was measured.

2.1.2 Results and discussion

On the first day after salting an unpleasant odour was noticed, and gas bubbled up from the interior of the batch.

Results after 17 days of storage:

Weight of salted fish:	13,2 kg
Yield of salted fish:	66,1%
pH of brine:	5,7

Solid salt was still present between the fish.

The bigger fish of the species macujana (Boulengers croaker, *Johnius belangerii*) and magumba (Kelee shad, *Hilsa kelee*) were inflated from gas formation in the belly cavity and the entrails were foul smelling and partly dissolved. The foul smell had spread to the whole batch which was considered unfit for human consumption.

It was estimated that the salt had not penetrated sufficiently rapidly into the viscera and into the thicker parts of the flesh of the biggest fish to stop bacterial and enzymatical breakdown. It was decided to study the influence of fish size on the result of the salting and at the same time secure a better contact between fish and salt by using saturated brine with excess of salt.

2.2 Salting of By-catch on Board

2.2.1 Materials and methods

The shrimp fishery was followed on board a commercial shrimp trawler from SULPESCA, Maputo. The fish was sampled from the first haul.

Experimental data:

Date of initiation of the experiment:	22.03.1984
Trawling time:	1 h, 56 min
Water temperature:	28°C
Air temperature:	27°C

Ten kilogrammes of third grade fish mainly below 45 g were selected for salting. Size grading was carried out visually. No weighing or measuring was done, as it was considered of major interest to salt the fish as quickly as possible after catching. The fish were mixed with 5 kg of salt in a plastic container and 4 litres of saturated brine were added on top in order to secure the maximum contact between fish and salt. A lid kept the fish below the surface of the brine. Salting was finished 1 h and 12 min after loading the fish on board. After being unloaded at the end of the day the container was stored at the Institute for Fisheries Research at ambient temperature.

The salted fish were inspected visually and brine concentration was measured by salinometer at frequent intervals. The experiment was ended after 4 days and the fish were weighed and examined for inflation by gas formation. All fish of 20 g salted weight or above was weighed individually. Fish below 20 g were counted and weighed together. Fish floating briefly dip in 10% brine were considered inflated. Selected inflated and non-inflated fish were cut open in order to check that this method actually separated fish with spoiled viscera from fish with non-spoiled viscera.

2.2.2 Results

Time after salting:	5 h	29 h	48 h	96 h
Brine temperature:	27°C	27°C	26°C	25°C
Brine concentration, surface:	-	22.5%	22.5%	24.0%
Brine concentration, bottom:	-	22.0%	24.0%	24.0%
Weight of salted fish:	-	-	-	8.79 kg
Yield of salted fish:	-	-	-	76%

Inflated fish were noticed after 29 h. After 96 h it all smelt strongly of spoiled fish and the whole batch was found unfit for human consumption.

Results of size distribution and gas formation are shown in Figure 1. The fresh fish weight is calculated from the weight of the salted fish and the overall yield of 76%.

Between 75 and 80% of the fish was below the intended limit of 45 g fresh fish weight. Macujana accounted for 32.2% of all the fish. The majority of the rest was corvina (tiger tooth croaker, Otolithes ruber) and ocar (malabar thryssa, Thryssa vitirostris); 9.6% was flatfish of different species. Magumba (kelee shad, Hilsa kelee) was not present, being mainly above 45 g.

The amount of fish inflated was 13.7% . Of this, macujana accounted for 12.9%. Of other species only two individuals were found inflated: 1 ocar of 13 g and 1 pescadinha (silver sillago,

Sillago sihana) of 64 g. The smallest inflated macujana was of 28 g salted weight corresponding to 37 g fresh weight. Size distribution and occurrence of gas formation of macujana is shown in Figure 2.

2.2.3 Discussion

As seen from Figures 2 and 3 gas formation is less common in the groups of 0-19 g and 20-29 g salted weight. The frequency grows with size above this limit. Allowing for a few inflated fish in industrial practice a size limit can be fixed in the interval of 20-29 g salted weight. As the smallest macujana which showed gas formation weighed 28 g salted weight a reasonable limit can be set at 27 g salted weight corresponding to 35 g fresh weight.

3. DISCUSSION AND CONCLUSIONS

It is concluded that only fish of 35 g or less can be salted whole on board at ambient temperature. Although not all fish above this limit may get spoiled if salted whole, only a minor fraction of spoiled fish may contaminate the batch and cause rejection for human consumption.

The consequences of this conclusion are that to use salting of by-catch on board as a preservation method it is necessary:

(1) to chill the salted fish during the first day or two;

(2) to separate and eviscerate or split fish bigger than 35 g before salting;

(3) to separate fish bigger than 35 g for preservation by freezing or other methods or for transfer to shore by collector vessels.

Solution 1 is relatively complicated, and would partially eliminate the advantage of salting on board.

Solution 2 would require much labour, as the fish to be eviscerated or split is still numerous and very small. Simple mechanical equipment for grading according to size is available (Olsen and Hansen, 1977) and may be installed on board, but it is doubtful whether a suitable gutting machine can be found to eviscerate fish between 35 and 100 g of all shapes and species. Furthermore, this solution will bring more mechanical equipment on board which is susceptible to maintenance problems and break-downs.

Solution 3 may have some limited application. Big fish of first grade is already being frozen on board (Jensen, 1985). However, the fraction of fish to be frozen may be too high for the capacity of the refrigeration equipment on board if it is expanded to all fish above 35 g. If transfer at sea has to take place third grade fish could be transfered as well, and salting would not be necessary except for the preservation of the fish until collection can take place.

Based on these results, salting on board is considered of little interest to the Mozambican shrimp fleet. However, the results may have some applications on shore, especially in the elaboration of standards for salting and drying of fish. The existing proposal for a standard (Mozambique, Department of Fish Technology, Institute for Fisheries Research, 1983) mentions 20 g as the upper limit for fish being salted whole. This limit may eventually be lifted to 35 g if salting experiments with fish from fresh water give similar results.

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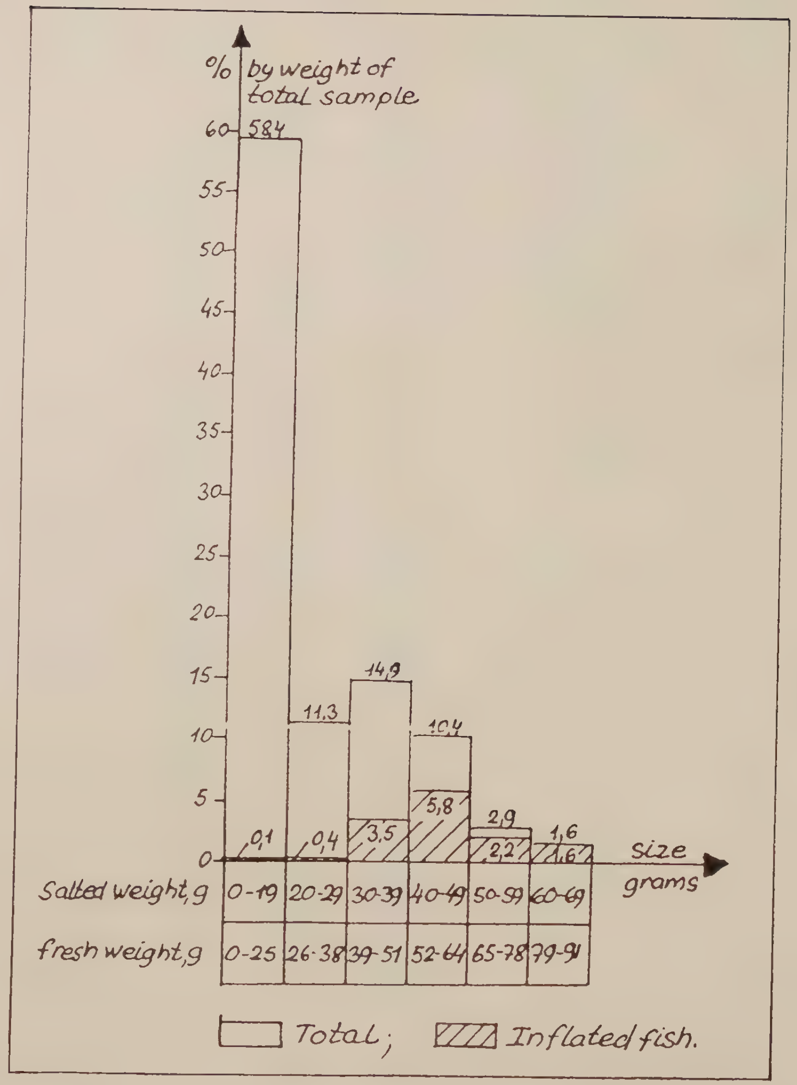

Figure 1 Size distribution and occurrence of gas formation in by-catch from the shrimp fishery

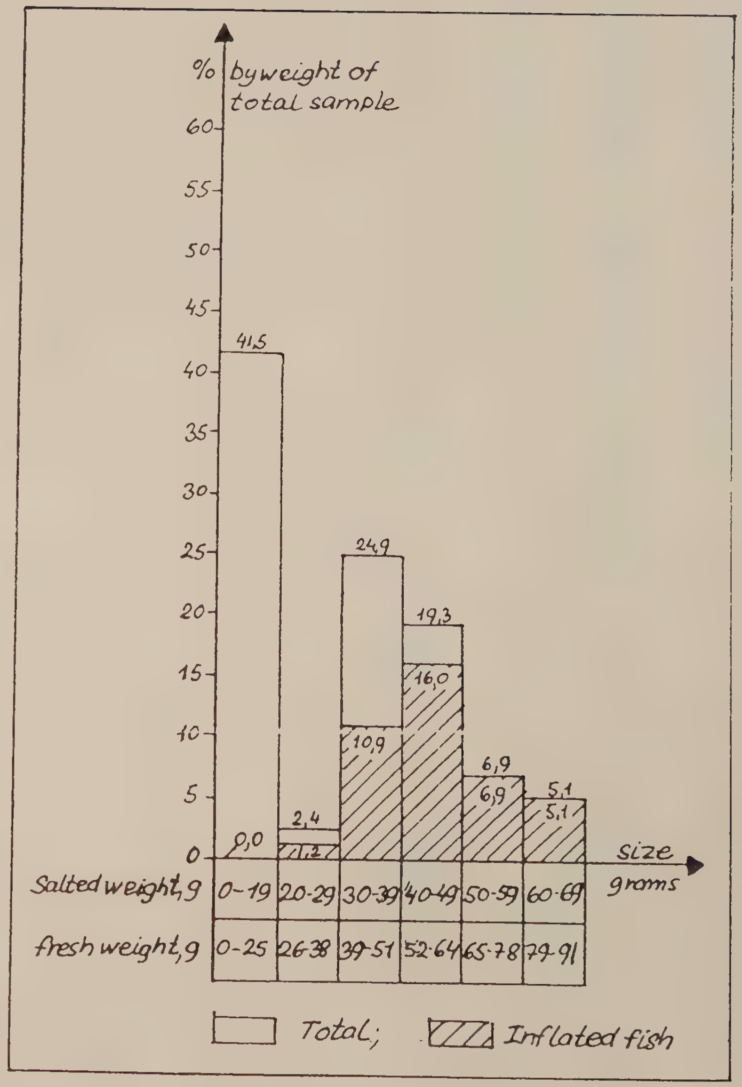

Figure 2 Size distribution and occurrence of gas formation in Macujana (Boulengers croaker) caught as by-catch in the shrimp fishery

HANDLING OF MAGUMBA (Hilsa kelee) FROM THE BAY OF MAPUTO

by

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ABSTRACT

Severe quality problems were detected in the hot season in canning magumba (kelee shad, Hilsa kelee), which is landed uniced after one-day fishing trips. Different handling methods were studied in order to solve the problems. It was found that the current practice involving delayed chilling of the fish in a frozen storage room on shore overnight gave a raw material unacceptable for canning with a total storage life in ice and water of 5-6 days.

Delayed chilling in ice and water on the pier after unloading gave a reasonably good raw material for canning with a total storage life of 10 days. CSW storage on board gave an excellent raw material for canning with a total storage life of 12 days.

The results show that an immediate solution to the problems may be the chilling of the fish on the pier, but that the best solution must include chilling on board. The installation of a 2.4 m^3 CSW-champagne tank on board is suggested, and the report contains a description and discussion of the installation, the operation and the economics of the CSW system.

1. INTRODUCTION

Magumba, in English kelee shad (Hilsa kelee), is a small pelagic semi-fatty fish of the Clupeidae family. It is caught in shallow waters along the coast of Mozambique, mainly close to river mouths in gillnets or shrimp trawls. It is usually between 40 and 110 g with an average weight close to 60 g when caught in this way in the Bay of Maputo. A study of the biology of the magumba including relationships between size, weight and age has been carried out by Souza (1982).

In 1983 the state-owned company SULPESCA had 21 boats fishing magumba by gillnet in the Bay of Maputo; 6 of these were wooden boats of different size and shape and 15 were fibreglass vessels of the Rodman type shown in Figure 1. The total magumba catch by SULPESCA in 1983 was 549 t, with an average of 214 kg of fish per voyage (SULPESCA, 1984). The fish is mainly used for canning and for salting and drying. No chilling is applied on board, and in 1983 fish was not chilled before it was put into the cold storage room of the canning factory in Maputo. There it was stored overnight in piles of wooden boxes at temperatures close to $-10^{\circ}C$.

This practice caused some damage to the fish quality, especially during the hot season. The yield at the cannery was reported to be strongly dependent on the fish quality. For example, a box of 23 kg of good-quality fish might give a yield of 13-14 kg of dressed fish whereas lower quality fish might yield only 11-12 kg which is a decrease of 15%. When the hot season started, the cannery had to close down frequently due to lack of suitable raw material and all magumba were utilized for salting and drying or for production of fish silage.

The present study was initiated in order to find a solution to the problems described and give guidelines for adequate and practical handling and chilling methods for canning, salting and drying.

2. MATERIALS AND METHODS

2.1 Definition of the Problems On Board

Prior to planning the experimental work, the fishery of magumba was followed on board a boat of the Rodman type. These are day boats which leave the port at 6.00 a.m. and return at 2.00-3.00 p.m. They fish with gillnets, which are laid out in a line in the area where the fish are detected, whereafter the boat returns to the starting point immediately, and begins the hauling of the net. The whole operation may take 25-30 minutes if the catch is less than 100 kg, but more than 1 hour if the catch is good. Five of the six crew members are engaged in shaking the net when it is hauled in by hand before being arranged in the stern, and the fish spread all over the deck area. The fish stay on the deck during the voyage, around the hatch to the hold. If the catch during the day passes 200-300 kg, the fish fill the centre of the deck and it is impossible not to step on it during fishing operations.

The fish hold is about 115 cm high and 360 cm long. It is not used because of the difficulties of working there in a crouched position. The hatch is too small (58 x 58 cm) for a person to stand up in the opening and at the same time pass a box of fish to the hold. In order to reach the front part of the hold for unloading or cleaning, it is necessary to crawl the 280-cm from the hatch to the front bulkhead.

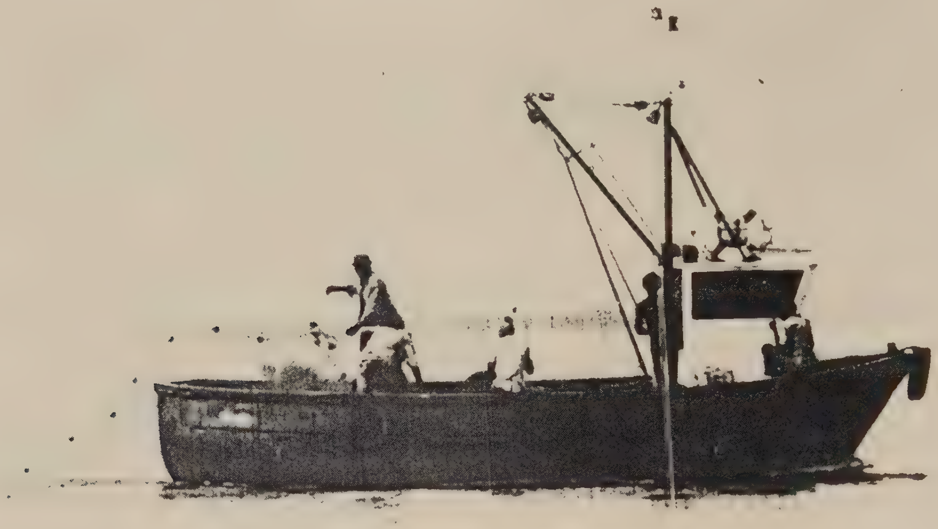


Figure 1 The gillnet being set from a fibreglass magumba boat of the Rodman type

It was concluded that the use of the hold for bulk storage of fish with ice or storage of fish in boxes with ice would not represent a viable solution. Icing in boxes on deck would be impossible, as all the deck space is needed for working operations and it might cause excessive ice meltage.

A solution might be the installation of a fixed insulated tank in the hold for chilling of the fish by the CSW-champagne system. The fish from each catch could simply be put into the tank already loaded with ice and sea water, and chilled down with the help of air introduced through perforated pipes in the bottom, in order to mix fish, ice and water.

The introduction of this handling system would require some construction work. It might be argued that it would be simpler to leave the fish on board without icing for the 2-8 hours it takes to bring it ashore, and then carry out the chilling at the pier. A handling and storage experiment was started in the hot season to compare chilling the fish on board, with chilling it on the pier, and the traditional handling method described in the introduction, where the fish is first chilled after reaching the factory.

2.2 Experimental Plan

The magumba were caught by gillnet on one of the Rodman boats belonging to SULPESCA, Maputo. Fish from the first catch were divided into three lots:

Lot IC: Immediate chilling. Thirty kilogrammes of magumba were chilled in ice and sea water in an insulated container of 70 litres within 30 minutes of catching in order to simulate the chilling in a CSW-champagne system.

Lot DC: Delayed chilling. Fifteen kilogrammes of magumba were left unchilled in a box on the deck exposed to the sun and wind. On landing, 8 hours after catching, it was chilled in an insulated 70-litre container with ice and water.

Lot P: Current Practice. Fifteen kilogrammes of magumba were left unchilled in a box on deck exposed to the sun and wind. On landing, 8 hours after catching, the sample was divided between three plastic bags and placed in a thermostatically controlled freezer at -10°C. This simulated the practice where fish landed in the afternoon is placed overnight in piles of wooden boxes in the cold storage room operating around -10°C. The following morning, 26 hours after catching, the sample was placed in the 70-litre insulated container with ice and water.

All the samples were maintained at 0°C in ice and water during the rest of the experiment, until rejected for consumption at quality assessment. More ice was added and surplus water removed when necessary.

2.3 Experimental Data

Initiation of experiment:		10 January 1984
Time of catch:		8.17 a.m.
Weather:		Slightly cloudy to clear. Light wind
Temperatures:	Water:	28°C
	Air:	28°C, rising to 31°C during day
	Fish:	28°C at catch, rising to 35-37°C for fish exposed to sun during the day

Lot P:

Temperatures when leaving the freezer after 18 hours storage:

Centre of bags:	-1.4°C to +3.1°C
Surface of bags:	-6.6°C to +0.4°C

2.4 Canned Samples

Samples from the three lots were descaled by machine 48 hours after catching, nobbed and canned in 94 x 88 mm diameter cylindrical cans, volume 370 ml, in tomato sauce; 220 g of raw fish was packed into each can (no precooking was applied) and sterilized for 1 hour at 121°C (emerging time approximately 30 minutes), giving a product with a drained weight of approximately 175 g. This is common practice at the canning factory, where the production of samples took place.

2.5 Analysis

Organoleptic assessment of the stored fish was carried out on the raw and cooked fish 1, 3, 7, 10 and 13 days after catching, by an 8-person panel leaving out rejected samples at the next assessment. A scoring system from 10 to 0 was used, where 10 is excellent, 8 is good, 6 is neutral and 4 is the limit of acceptability for human consumption. The corresponding quality graduations into extra (A), good (B), acceptable (C) and non-acceptable (D), used by the Mozambican Ministry of Health (1983) is shown in Figures 2 and 3. Only fish of quality A and B may be used for canning and fresh consumption. Fish from groups A, B and C may be used for salting and drying, and fish from group D must not be used for human consumption.

Fish for cooked evaluation was nobbed, scaled and cooked in boiling water with 2% salt before serving to the panel members.

The 95% interval of confidence was calculated by two-way analysis of variance. The results are shown in Figures 2 and 3.

Canned samples were analysed 33 days after production by a group of three persons including the factory Production Manager and the quality control supervisor at the factory, using the scoring system as for fresh fish. The results are shown in Table 1.

Table 1

Evaluation of automatic descaling prior to canning and quality assessment of the canned product

Lot	Result of descaling	Quality assessment with 95% interval of confidence
IC	Excellent	8.0 + 0.6
DC	Reasonable	6.7 + 0.6
P	On the limit of acceptability	4.7 + 0.6

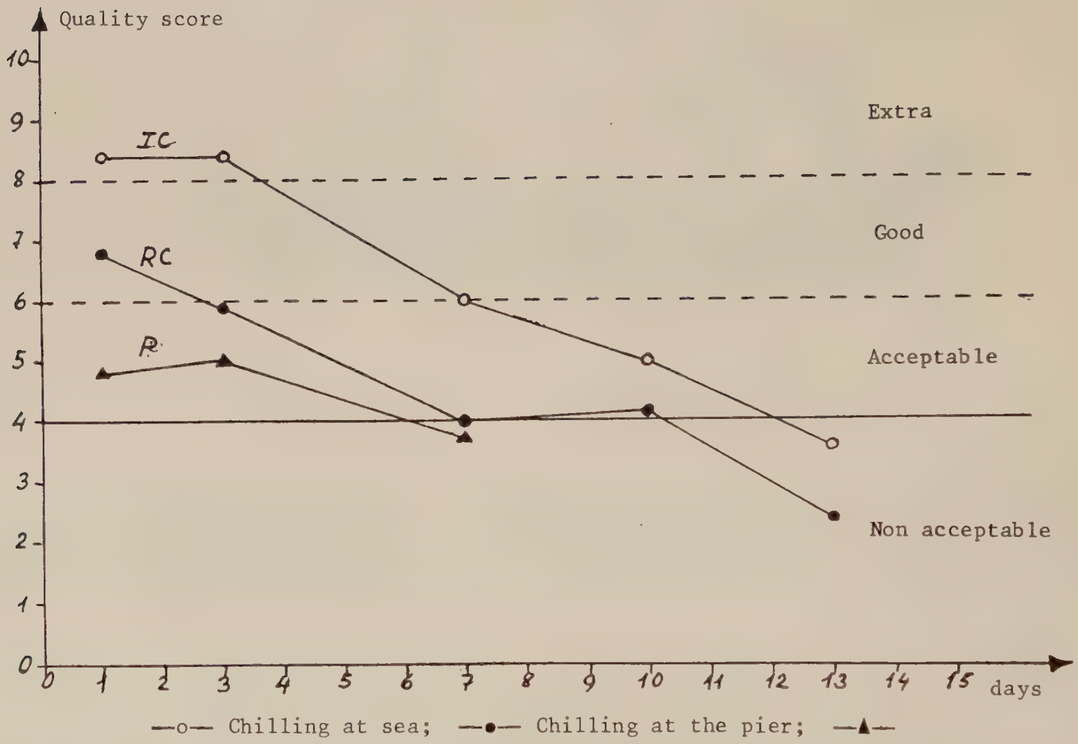


Figure 2 Results from quality assessment of magumba handled in different ways. Raw evaluation (95% interval of confidence: days 1 and 13: ±1.1; day 3: ±0.9; days 7 and 10: ±1.0)

3. RESULTS AND DISCUSSION

The results from the quality assessments of the raw and cooked samples shown in Figures 2 and 3 show a considerable improvement in quality when chilling is applied on board in ice and sea water (Lot IC). This fish may be used for canning and fresh consumption for 7 days after catch, and for salting and drying until 12 days after catch.

Chilling at the pier (Lot DC) also improves quality, but only to a limited extent. This fish may be used for canning or fresh consumption up to 3 days after catch, and for salting and drying up to 7-10 days after catch.

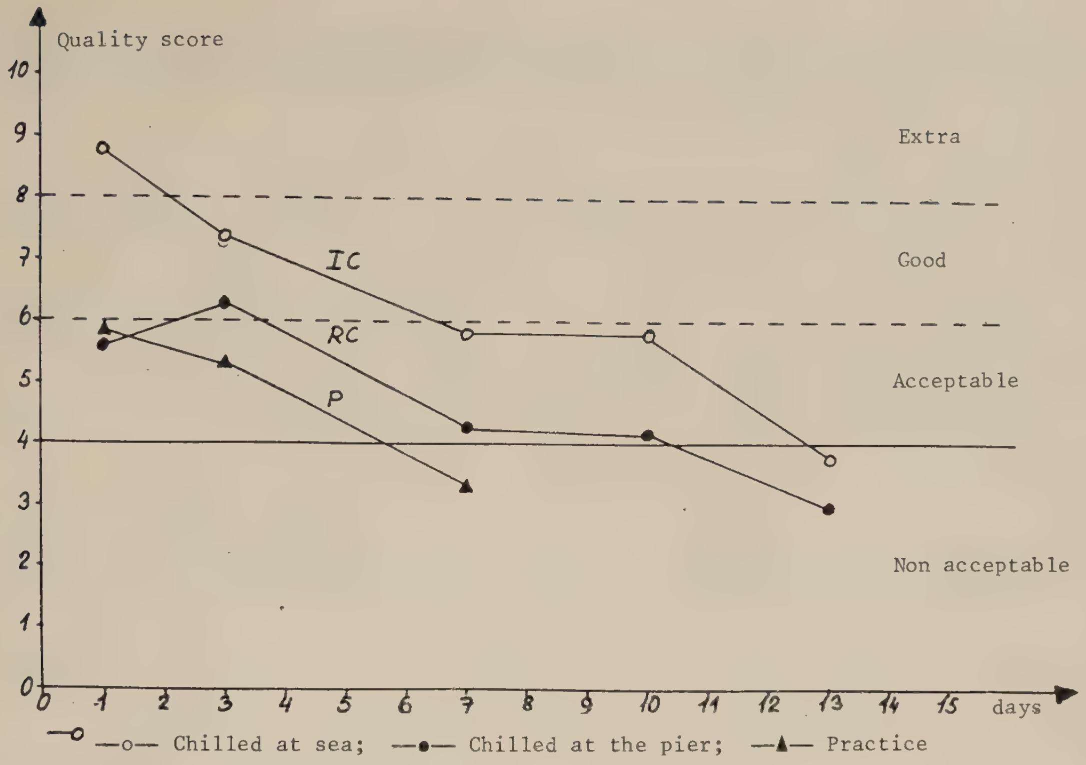


Figure 3 Results from quality assessment of magumba handled in different ways. Cooked evaluation (95% interval of confidence: days 1 and 13: ±1.3; day 3: ±1.1; days 7 and 10: ±1.2)

Fish treated according to practice (Lot P) was not at all acceptable for canning and could be used for salting and drying only up to 5-6 days after catch.

The quality and especially the firmness of the fish is important in canning and essential for mechanical descaling. Table 1 shows the results of descaling and quality assessment of the canned samples.

The factory already possesses an automatic scaling machine, but it is rarely used as it breaks up the soft fish. When used on good-quality fish it can descale 250 kg/h, which is the same output as 12 operators descaling by hand. Using descaling by machine and gutting and heading by hand, productivity can be raised from 110 kg to 330 kg/operator/8 h. This gives a clear indication of the economic impact of chilling at sea.

Also the quality of the canned samples is clearly improved by chilling the raw material at sea and, to some extent, by chilling at the pier, compared with current practice.

4. CONCLUSION

The results indicate clearly that it is important to chill the magumba at sea, as this will give better quality final product, result in stable production of canned fish. The factory will secure a suitable raw material for canning on all days with sufficient fishery and be able to store surplus fish for up to 7 days after catching to maintain production on days with little or no catches. Also productivity and yield may be increased by chilling at sea.

The CSW-champagne system could be the only viable solution to chilling on board the Rodman boats, due to their special construction and the working practice during the gillnet fishery. While this system is being studied or introduced, an immediate but preliminary solution may be to unload the boats as soon as they enter the port and ice the fish on the pier.

5. IMPLEMENTATION OF THE RESULTS

5.1 Icing on the Pier

Icing of the fish on the pier for canning was introduced in January 1984, and this allowed the cannery to start working with magumba again.

5.2 The CSW-Champagne System

Icing the catch on the pier is only a preliminary solution. Any long-term solution to the problems must include chilling of the fish at sea. In the present situation the installation of the CSW-champagne system seems to be the best solution.

The champagne system, called so because it uses air bubbling in order to mix ice, sea water and fish, was developed in Canada. In the first seven years after the introduction, it was installed in more than 200 salmon seiners (Jensen and Hansen, 1983) and it has also been used in India (Roach, 1980) and Mexico (Jensen and Hansen, 1983) with good results.

In the case of the Rodman boat, shown in Figure 4, the CSW-champagne system can be installed in a single insulated tank in the centre of the hold.

The average catch per trip in the magumba fishery from Maputo, calculated from catch statistics in 1983 (SULPESCA, pers. comm.) including days with no or hardly any catch, is 214 kg. Catches are frequently 400-800 kg daily, but seldom exceed 1 000 and 1 500 kg. A CSW tank of 2.4 m^3, as proposed for the Rodman boats, will hold 1 400 kg of chilled fish (see Figure 6).

The tank is insulated with 5 cm polyurethane foam and lined inside with fibreglass. An air blower leads the air through a check valve, past a pressure relief valve and a pressure gauge into the bottom of the tank through two perforated air pipes, as shown in Figure 7. Roach (1980) gives detailed guidelines for the calculation of the capacity of the blower and the design of the piping system, which must fulfill certain conditions, and for the operation of the system.

It is proposed that the hatch for the hold is moved to the centre of the CSW tank, and that a small hatch is opened in the deck of the wheel house in order to be able to utilize the remaining hold volume for storage space.

A submersible "bilge pump" must be available for filling and emptying of the tank with sea water.

The construction of the tank can be carried out in Mozambique. Mechanical equipment must be imported. Estimated cost of the CSW system:

Construction of tank, including insulation, lining, workmanship:	Mt. 100 000
Piping:	Mt. 10 000
Airblower, magnetic clutch and immergible pump, etc.:	Mt. 60 000
Total investment	Mt. 170 000 (US$ 4 000)

The above price for airblower, clutch and pump is based on the purchase of equipment for six or more boats and shipment by sea freight. An installation for testing the system, with aquisition of single items by airfreight could cost for mechanical equipment up to Mt. 84 000 (US$ 2 000) and total up to Mt. 194 000 (US$ 4 600).

5.3 Ice Requirements

Assuming 10 hours from ice loading to unloading of the catch air and water temperatures of 28°C in the hot season and deck temperatures of 35°C and 40°C in the engine room, the ice loss to the surroundings will be 25 kg/10 h.

When fully loaded a further 625 kg of ice will be needed to chill 1 400 kg of fish and 350 litres of sea water, including a 10% ice surplus.

The amount of ice and sea water loaded should be adjusted for the expected catch. Generally, the fish to ice ratio can be calculated as 2:1. It is expected that a further 20% of ice will be lost due to overestimation of catches.

With an average of 16.5 voyages/month/boat (SULPESCA, pers. comm.) and 214 kg of fish per voyage, the annual catch per boat is expected to be 42.4 t, and the annual requirement for ice approximately 25.4 t/boat. The price of ice is Mt. 1 000/t (US$ 240/t).

5.4 Mode of Operation of the CSW-Champagne System

(a) In the harbour

Ice will be loaded into the insulated tank by chute before leaving the port. Approximately half the quantity of the expected catch (by weight) should be loaded.

(b) Outside the harbour

Clean sea water is loaded corresponding to about half the weight of the ice. This is usually completed when water starts to be seen between the ice particles, and it is just before the ice starts to flow, provided that the ice is spread evenly over the bottom of the tank. Air is bubbled through the ice and water for approximately 10 minutes, or until it is well mixed.

(c) On the fishing ground

Air blowing is started 10 minutes before the fish is loaded into the tank and continued for 10-30 minutes after, until fish, water and ice are well mixed. This procedure is repeated each time the gillnet is set.

(d) In the harbour

The fish is unloaded by scoop, as shown in Figure 7.

5.5 Evaluation of the CSW-Champagne System

The CSW-champagne system is expected to give a number of advantages both in the processing of the fish and in the quality of the products, as mentioned in Section 4. On board it will give better working conditions, but a slightly more complicated unloading procedure.

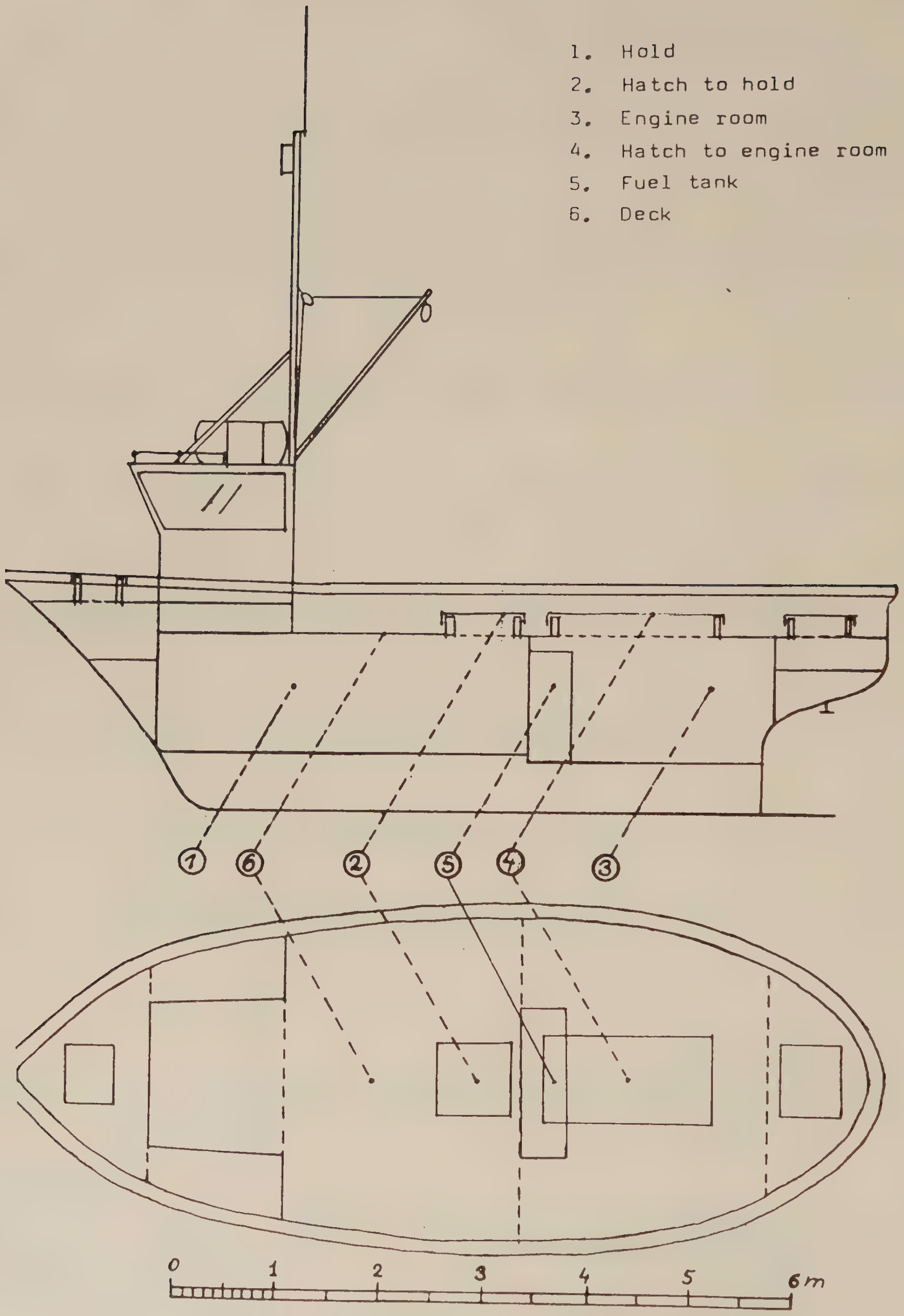
The maintenance of the system is simple. The air pipes should be installed in a way that they can be easily dismantelled and cleaned with steam or hot water if blocked. The electrical equipment and blower, operated from the main engine should need no different maintenance from the other equipment on board.

The presence of a tank on board, half full of water, might affect the stability of the boat, however, the Navipesca shipyard in Maputo (pers. comm.) estimates that the influence is minimal in the chosen position of the tank amidships.

The system will increase fish cost compared to the existing practice, where no ice is used at all. Assuming a life of five years for mechanical equipment and piping, and 10 years for tank and insulation, the cost of the system can be calculated in the following way:

	Mt.	
Total investment:	170 000	(US$ 4 000)
Annual costs:		
Depreciation	24 000	
Interests, 15% per year	25 500	
Maintenance, 2%	3 400	
Ice, 25.4 t	25 400	
Total	78 300	(US$ 1 860)
Cost per kg at an annual catch of 42.4 t	1.85	
Present price of magumba/kg	25.00	
Total cost	26.85	(US$ 0.64)
Cost increase	7.4%	

This cost increase can be recovered in 6 months if the canning factory yield rises by 15%. In addition benefits of higher productivity, better product quality, lesser losses, etc., would accrue. The CSW-champagne system seems to be an economical feasible solution to the handling problems.



1. Hold
2. Hatch to hold
3. Engine room
4. Hatch to engine room
5. Fuel tank
6. Deck

①
⑥
②
⑤
④
③
0
1
2
3
4
5
6m

Figure 4 Sketch of the Rodman boat

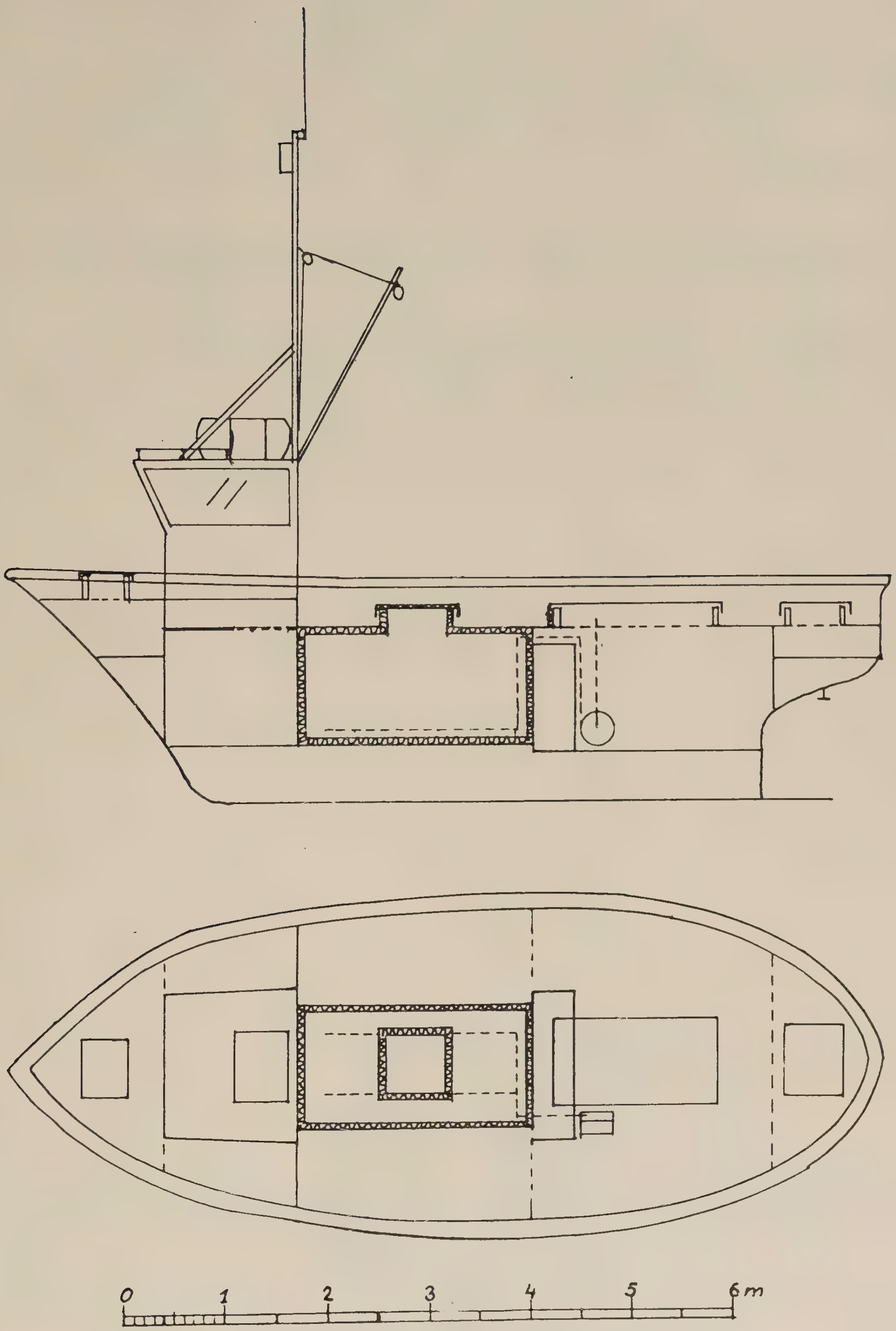


Figure 5 Proposed installation of a CSW-champagne tank in the Rodman boat

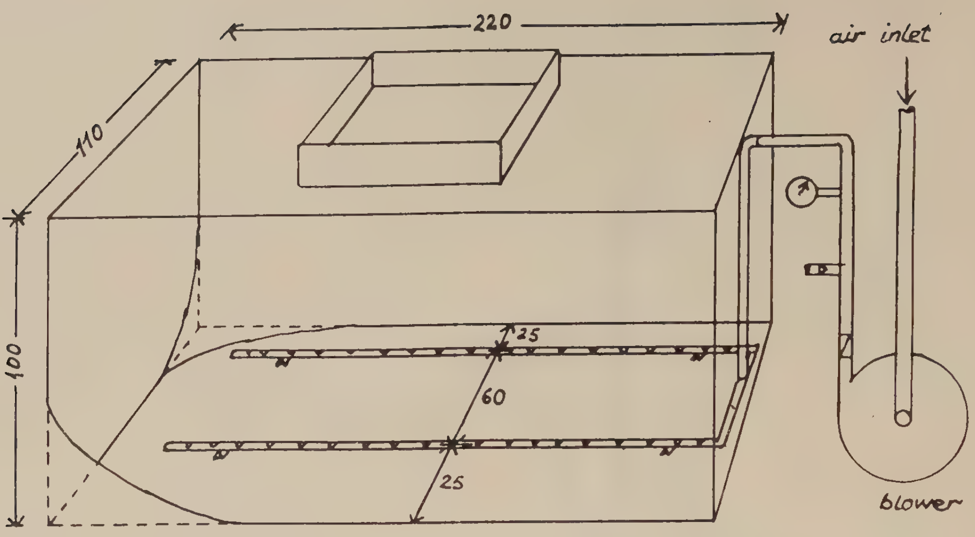

220
air inlet
110
100
25
60
25
blower

Figure 6 Sketch of the CSW-champagne system

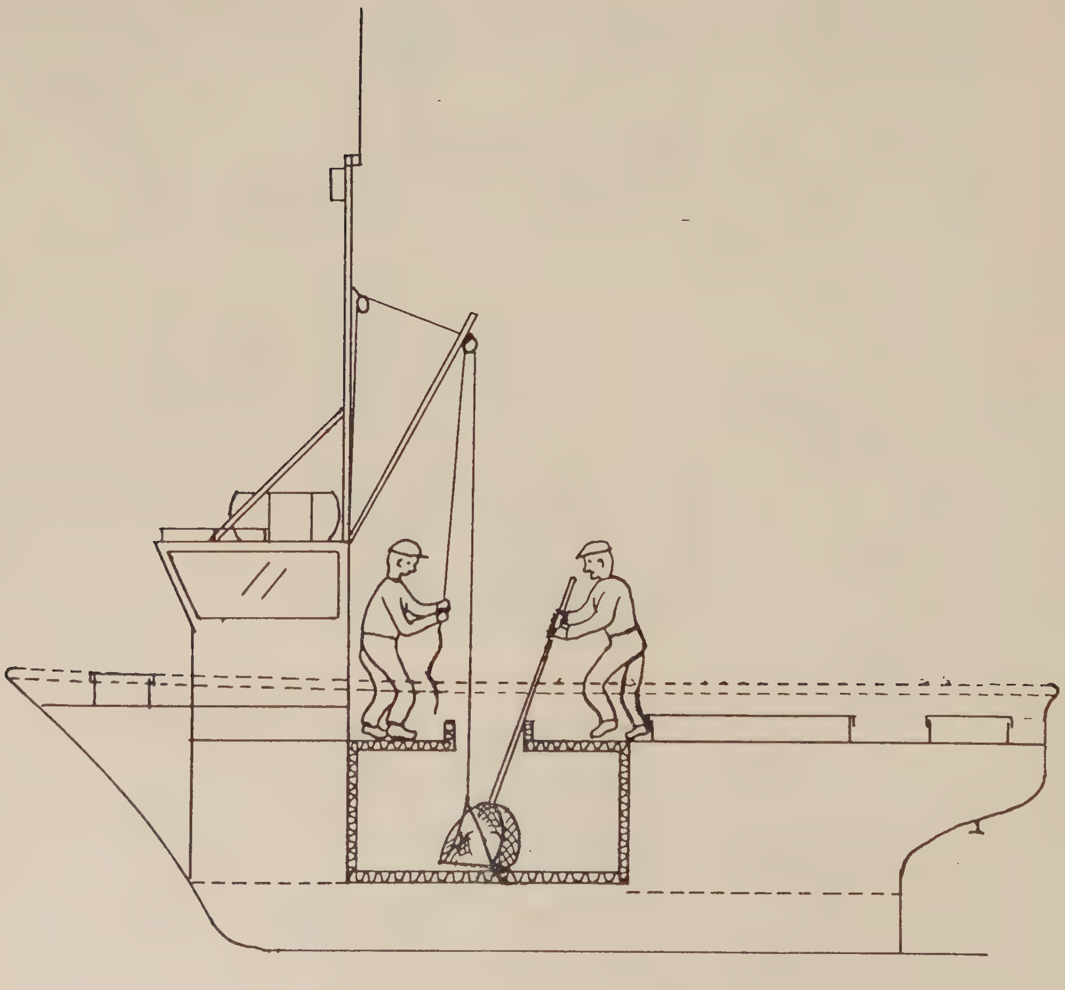


Figure 7 Unloading of fish from the CSW tank by scoop

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ETUDE DE LA TECHNOLOGIE APPROPRIEE A LA CONSERVATION DU POISSON FRAIS DE PECHE ARTISANALE

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RESUME

La communication porte sur les alternatives technologiques offertes au secteur du mareyage de poisson frais de pêche artisanale par l'usage de containers isothermes depuis la capture jusqu'à la commercialisation. En outre, le contenu énergétique de la conservation des prises artisanales par la glace va être comptabilisé tout au long de la chaîne d'écoulement vers les zones locales de consommation ou les usines d'exportation.

1. INTRODUCTION: LE MAREYAGE DE POISSON FRAIS AU SENEGAL

Le mareyage du poisson frais constitue une importante activité dans les centres de pêche artisanale. L'essor de ce secteur date de l'avènement de la monnaie dans le milieu pêcheur et s'est intensifié avec la modernisation des techniques artisanales de pêche et le désenclavement des centres de débarquement. Les différences observées entre centres de pêche s'expliquent:

- d'une part par la nature et l'importance du poisson débarqué;
- d'autre part par les caractéristiques socio-économiques suivantes: importance des populations vivant autour du centre de pêche; importance de la demande de poissons des centres urbains environnants, infrastructures routières; organisation du mareyage et pouvoir d'achat des consommateurs.

Le recours aux marchés et usines d'exportation pour écouler les captures artisanales a introduit dans le milieu pêcheur des bouleversements socio-économiques multiples et variés:

- abandon des pêcheurs des autres activités agricoles au profit de la pêche exclusive;
- commercialisation des captures par les femmes de pêcheurs (travaillant de plus en plus à leur propre compte en tant que représentantes des pêcheurs) et par d'autres hommes et femmes mareyeurs jadis paysans et paysannes totalement étrangers au secteur des pêches.

Ainsi le mode de production rurale, jadis en vigueur dans les familles de pêcheurs, disparaît peu à peu et la notion de salariat se développe de plus en plus dans les opérations de mareyage; le travail humain reste la principale source d'énergie au centre de pêche (cf. tableau 1) bien que le transport du poisson frais se fait quelquefois par charrettes de la pirogue à l'aire de glaçage et par camions des centres de pêche aux zones de consommation du pays. Le caractère artisanale du mareyage permet en principe d'assurer la distribution du poisson frais aux populations de toutes conditions, mais cette répartition est fonction de la bourse des consommateurs (cf. tableau 2). Ainsi, la majeure partie des poissons mareyés dans le pays est constituée d'espèces pélagiques de faible valeur commerciale (telles les sardinelles, l'ethmalose, le chinchard, le mulet, le maquereau, etc.), les espèces benthiques de valeur commerciale moyenne (mérous, dentex, courbines, etc.) ou élévée (soles, lottes, crustacés et mollusques) étant destinées aux consommateurs urbains plus ou moins aisés ou exportées par les usines dakaroises.

La technologie des mareyages du poisson frais dépend de plus en plus du marché d'écoulement - d'autant que l'étape de la modernisation des techniques de pêche ne s'est pas accompagnée de mesures administratives - et l'introduction de méthodes efficaces d'écoulement des captures artisanales. Cela a favorisé l'émergence rapide des mareyeurs qui, en quelques années d'exercice, sont en train de marginaliser les femmes de pêcheurs jadis commerçantes attitrées de poissons frais et prendre ainsi le contrôle de l'économie halieutique artisanale.

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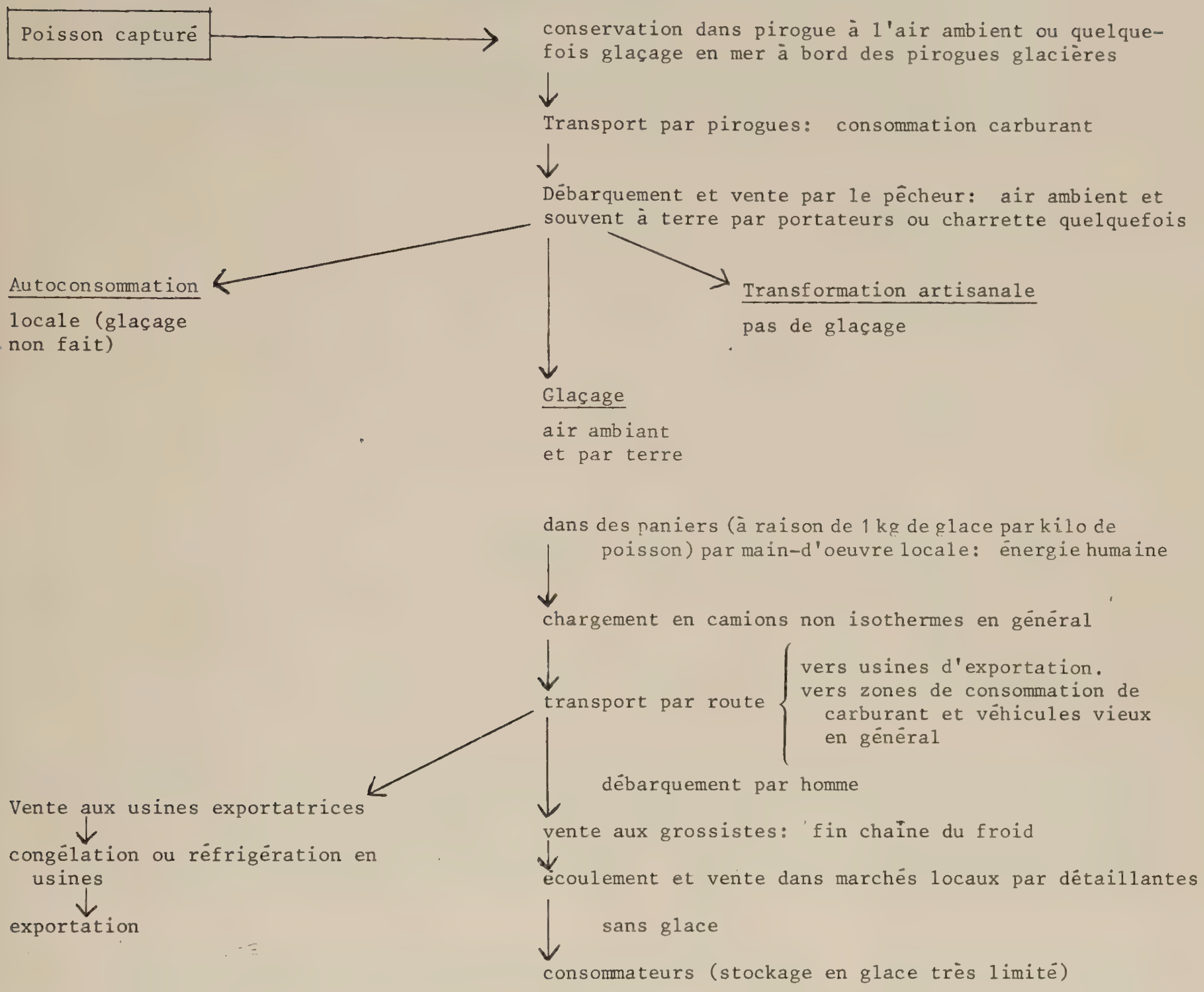
[1] Chercheur technologie conservation et traitement des produits de la pêche

Tableau 1

Chaîne de technologie du mareyage du poisson frais
de pêche artisanale



Poisson capturé

conservation dans pirogue à l'air ambient ou quelquefois glaçage en mer à bord des pirogues glacières

Transport par pirogues: consommation carburant

Débarquement et vente par le pêcheur: air ambient et souvent à terre par portateurs ou charrette quelquefois

Autoconsommation
locale (glaçage non fait)

Transformation artisanale
pas de glaçage

Glaçage
air ambiant
et par terre

dans des paniers (à raison de 1 kg de glace par kilo de poisson) par main-d'oeuvre locale: énergie humaine

chargement en camions non isothermes en général

transport par route
vers usines d'exportation.
vers zones de consommation de carburant et véhicules vieux en général

débarquement par homme

vente aux grossistes: fin chaîne du froid

écoulement et vente dans marchés locaux par détaillantes

sans glace

consommateurs (stockage en glace très limité)

Vente aux usines exportatrices

congélation ou réfrigération en usines

exportation

Ainsi la chaîne du froid est incomplète en général, la glace est utilisée pour assurer le transport du poisson frais du centre de pêche aux zones de consommation à l'intérieur du pays.

L'emprise économique et financière du milieu pêcheur par les mareyeurs ne cesse de s'accentuer et devient préoccupante compte tenu de leur hostilité à l'opération CAPAS visant à harmoniser le statut social des pêcheurs à leur mérite. Quant aux usiniers dakarois, ils assurent aux mareyeurs les moyens techniques et financiers de ramassage des espèces halieutiques (de valeur commerciale moyenne ou élevée) dans les centres de pêche pour les besoins d'exportation au détriment des consommateurs ruraux et urbains à revenus jugés modestes pour instaurer un circuit moderne de mareyage à travers le pays.

Seule la solution de ces différentes carences d'ordre technique, social et économique par une technologie appropriée au circuit d'écoulement des captures en zone tropicale (à température et humidité relative élevées) peut permettre d'assurer une distribution du poisson frais dans de bonnes conditions à travers le pays.

Tableau 2

Répartition des captures marines artisanales et des quantités mareyées de produits frais entre les différentes régions sénégalaises (1981)

Pourcentages Régions	Taux d'absorption des quantités mareyées	Taux de production des captures artisanales
Cap Vert (Dakar)	40,49 %	13,62 %
Thiès	18,23 %	60,33 %
Sine Saloum	11,84 %	14,64 %
Diombel	5,94 %	0 %
Casamance	6,90 %	6,71 %
Fleuve	8,31 %	4,58 %
Longa	3,21 %	0,12 %
Sénégal oriental	1,94 %	0 %

Source DOPM: le tonnage mareyé en 1981 s'élève à 81,843 t

2. LA CHAINE DE FROID DU POISSON FRAIS DE PECHE ARTISANALE

Les pêcheurs et les mareyeurs ont adapté la technologie de réfrigération du poisson frais aux conditions locales du pays tout au long de la chaîne de manutention et distribution des captures artisanales.

2.1 Approvisionnement en glace des centres de pêche

C'est une nouvelle catégorie de travailleurs du poisson qui assurent la fourniture de glace nécessaire au mareyage artisanal du poisson; les vendeurs de glace se ravitaillent en barres de glace auprès des fabriques de glace implantées dans les principaux centres urbains et le stockage se fait en coques d'arachide ou sciure de bois sans huttes. La consommation d'énergie par tonne de glace produite (en barre ou bloc) varie de 50 à 70 kwh (soit 115 x 10^3 à 161 x 10^3 kcal) selon le type de générateur à glace et la saison de production. Ainsi le prix de la glace dépend d'une part des frais d'exploitation et d'entretien des équipements d'usines à glace, et d'autre part de la situation et des conditions de vente du centre de pêche.

La durée de stockage des barres de glace en coques d'arachide ou sciure de bois varie de deux à cinq jours selon la saison et l'épaisseur de la couche d'isolation; en outre, l'offre et la demande de glace au niveau des vendeurs sont fonction des débarquements de poissons du centre de pêche.

2.2 Conditions de commercialisation du poisson réfrigéré

2.2.1 Conservation du poisson à bord des pirogues

La raréfaction des poissons démersaux le long de la côte, a contraint les pêcheurs à prolonger les temps de sortie en mer et utiliser de plus en plus des cales à glace, introduites par les pêcheurs Guet Ndariens vers 1976 pour les longues campagnes de pêche démersale au large des côtes mauritaniennes.

En 1984, le nombre de pirogues glacières (cf. schéma 1) ne cesse d'augmenter dans les principaux centres de pêche artisanale, la cale à glace est une caisse de contreplaqué à revêtement intérieur isotherme (cf. schéma 2), divisée en deux compartiments dont l'un est rempli de glace au départ pour la pêche; au fur et à mesure des prises, le poisson est glacé dans le second compartiment selon le taux de glaçage variable selon la saison. Les recettes des espèces démersales ainsi conservées sont parfois très importantes mais varient selon les espèces capturées et la situation du marché.

L'introduction des cales à glace au niveau de la pêche demersale représente une innovation technologique ayant permis aux pêcheurs d'augmenter les captures de moitié et de réaliser des économies de carburant (de 1/3 selon certaines estimations). En outre, ce sont les charpentiers fabricants de pirogues qui construisent ces cales et ne cessent d'améliorer, bien qu'insuffisamment, l'isolation thermique et l'étanchéité de ces contenants à glace en mer.

Quant aux pirogues non glacières dont le nombre dépasse 90 % du parc piroguier, l'espace restreint des embarcations, la quantité et la taille des espèces capturées représentent des handicaps à l'usage des cales à glace.

2.2.2 Conditions de débarquement et vente des captures par les pêcheurs

La carence presque générale de cales à glace dans les pirogues est un moyen de pression des mareyeurs sur les pêcheurs obligés de se débarrasser rapidement des captures selon les conditions artisanales de vente basées sur l'offre et la demande.

Le poisson est en règle générale, débarqué sur le sable et y reste le temps que le prix soit débattu; le dépôt sur la plage est évité lorsque le contenu est acheté par paniers ou en un seul lot (cas des pirogues à sennes tournantes). La pesée, le lavage et la mise en froid sont rarement pratiqués au niveau de la plage de débarquement.

2.2.3 Aires de glaçage

La production commerciale réfrigérée dans les centres de pêche peut être répartie en deux parts:

- celle qui est écoulée sur le marché intérieur sénégalais par des mareyeurs;

- celle qui fait l'objet d'exportation par les usines.

Les conditions de glaçage sont simples et sommaires; les mareyeurs ont adapté l'emploi de la glace aux conditions locales en utilisant les moyens matériels disponibles:

- coques d'arachides ou copeaux de menuiserie sous des huttes comme structures de stockage des barres de glace;

- paniers faits de lianes de roniers comme contenants de poissons glacés;

- air ambiant pour les opérations de glaçage se faisant souvent à terre la plupart du temps.

Mise en froid des espèces à faible valeur commerciale pour le marché intérieur

Les mareyeurs disposent d'une main-d'oeuvre permanente ou temporaire pour transporter les prises des pirogues à l'aire de glaçage et procéder aux opérations de refroidissement et chargement des véhicules de transport en fin d'après-midi généralement; la rénumération de la main-d'oeuvre se fait par paniers ou par mois.

La glace est concassée au gourdin dans les paniers quelquefois disposés sur une grande bâche, le plus souvent à même le sol boueux. Le poisson est mélangé à la glace en alternant les couches de poisson et celles de glace dans des proportions variables selon la main-d'oeuvre, la destination du produit et la nature des véhicules de transport. Le taux de glaçage exhorbitant (1 kg de glace pour 1 kg de poissons en moyenne) s'explique par la nature des véhicules simplement bâchés et l'ignorance des principes élémentaires de la réfrigération. Ainsi, le temps de refroidissement des espèces est très long et varie selon le taux de glaçage et la nature du véhicule d'écoulement.

Mise en froid des espèces destinées à l'exportation

Les mareyeurs achètent et réfrigèrent ces espèces selon la même technique de glaçage au fur et à mesure de l'arrivée des pirogues; toutefois, ils pratiquent l'achat au poids et le lavage avant glaçage à la demande des usiniers. En outre, ce sont des caisses isothermes (fournies par certaines usines dakaroises) ou des carcasses de congélateurs que l'on utilise pour le stockage du poisson glacé (cf. schéma 4) avant évacuation sur les usines dakaroises.

2.2.4 Conditions de commercialisation du poisson glacé

La chaîne du froid au niveau des structures de commercialisation du poisson glacé dans les zones de consommation se caractérise ainsi:

- transport de nuit avec des véhicules vétustes, dépourvus de toute isolation thermique et grands consommateurs de carburant (en moyenne 27,5 litres soit 250 x 10^3 kcal par tonne de poissons transportés);

- vente au détail sans glace au niveau des marchés locaux.

Quant aux poissons d'exportation, les camionnettes appartenant en général aux usines, sont en parfait état de marche et disposent de caisses à revêtement isotherme. En général, les conditions de manutention, mise en froid et conservation des produits (avant exportation) au niveau des usines sont correctes presque partout à la suite de remarquables améliorations au cours de ces dernières années.

Enfin, il est à noter l'existence d'un courant de vente au détail en atmosphère fraîche du poisson glacé qui s'adresse aux consommateurs urbains relativement riches au niveau de poissonneries et de supermarchés.

2.3 Hygiène des structures de glaçage et qualité des captures glacées

2.3.1 Au niveau des pirogues: cf. tableau 3

Les prises conservées dans les cales à glace présentent des qualités organoleptiques 1 à 3 à plus de 50 % des quantités débarquées. Toutefois les déchets sont très importants pendant les périodes chaudes de pêche; la qualité organoleptique de ces espèces peut être améliorée pour l'usage de plastique à la place du bois, le renforcement de l'isolation thermique et des trous d'évacuation de l'eau de fonte de la glace au niveau des caissons de glace. Quant aux poissons de pirogues glacières, ils présentent des qualités variables mais rarement très bonnes.

2.3.2 Au niveau des plages de débarquement et des aires de glaçage

Les sources de contamination microbienne du poisson sont multiples et variées:

- dépôt des captures à même le sable en attendant la vente;
- usage de barres de glace stockées avec tas de copeaux ou de coques d'arachide indéfiniment utilisés;
- opérations de glaçage à l'air ambiant et souvent à terre qui transforment les aires de réfrigération non bitumées en un sol boueux;
- emploi de contenants de poissons glacés en bois rarement nettoyés (paniers, véhicules de transport, tables de vente au détail notamment).

Il en résulte des produits de fraîcheur variable, rarement de très bonne qualité au stade de la vente au détail; en outre, la précarité des moyens de conservation et la vétusté des véhicules de transport se traduisent par d'importants risques pour les mareyeurs aux conséquences suivantes:

- la marge brute de commercialisation est très élevée: 150 à 200 % pour un profit net modeste de 15 à 25 % (Chaboud, 1982);
- les mareyeurs préfèrent commercialiser vers les centres urbains à revenus importants (Dakar notamment) et les usines plutôt que sur des circuits d'écoulement intérieurs à rendement faible.

Enfin, la présente situation ne favorise guère la mise en oeuvre d'une politique de commercialisation selon la qualité du poisson frais sans une formation adéquate des pêcheurs et des mareyeurs sur les principes, les avantages et les méthodes de réfrigération des captures artisanales comme aliment et denrée périssable.

2.4 Les améliorations en cours de la chaîne de froid

Parmi les efforts en cours pour améliorer la technologie de conservation du poisson en glace citons:

2.4.1 L'opération d'adaptation des containeurs isothermes à la forme et aux dimensions de la pirogue sénégalaise[1]

Les résultats d'expérimentation des deux premiers containers pendant 3 à 4 mois ont été concluants et ont permis de parfaire les caractéristiques techniques des 5 autres containers en expérimentation dans les 4 centres de pêche suivants: Saint-Louis, Lampoul, Hann et Joal.

L'étanchéité parfaite de ces containers améliorés permet:

- d'augmenter l'autonomie des pêcheurs en mer (marées jusqu'à 6 jours de mer et 1 jour à quai pour les gros containers);
- d'assurer une conservation meilleure des captures selon une relation glace-poisson de 0,5 kg (soit une économie de glace de 50 % par rapport aux caisses isothermes artisanales).

Le poisson garde les qualités organoleptiques suivantes au débarquement:

qualité 1: 85 %
qualité 2: 12 %
qualité 3: 3 % (correspondant aux poissons entassés au fond)

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[1] cf. Projet FAO/CAPAS/ITA: Amélioration de la conservation du poisson à bord des pirogues

Tableau 3

Enquêtes d'exploitation d'une pirogue à container artisanal à Joal
(sur 6 marées mars-avril 1984)

Frais	Montant des frais (FCFA)
Glace	75 000
Appât	30 000
Carburant	72 000
Nourriture	43 000
Total coûts d'exploitation	220 000
Chiffre d'affaire	480 000
Bénéfice équipage de la pirogue	260 000
Caractéristiques de la cale à glace	
- coût de construction	120 000
- durée de vie	24 mois
- amortissement annuel	60 000
- entretien annuel (30 %)	36 000
Caractéristiques de la pirogue motorisée	
- coût construction pirogue	380 000
- durée de vie	8 ans
- amortissement annuel	47 500
- entretien annuel 5 %	19 000
- investissement moteur	285 000
- durée de vie	2 ans
- amortissement annuel	142 500
- entretien annuel 10 %	28 500
Nombre de marées/an	66 marées (de 3 jours en moyenne)

alors que les espèces débarquées des containers artisanaux glacées selon la relation glace-poisson de 1 kg (en moyenne) présentent la cotation organoleptique suivante:

qualité 1:	9 %
qualité 2:	17 %
qualité 3:	40 %
qualité 4:	17 %
qualité 5:	17 %

En outre, la taille des espèces et le prétraitement (éviscération et saignée notamment) avant mise en froid prolongent le maintien des qualités organoleptiques 1 et 2 de quelques jours (4 jours pour les mérous).

Bien que le coût des containers améliorés soit 2 fois supérieur à celui des containers artisanaux, les avantages des containers améliorés permettent de compenser cet investissement supplémentaire par:

- une durée de vie plus longue;
- et une économie de glace (700 kg de glace par marée pour containers améliorés contre 1 150 kgs pour containers ordinaires).

Tableau 4

Méthode organoleptique. Barème de cotation

Caractères observés sur le poisson		Appréciation organoleptique des caractères et cotation				
		Qualité 0-1	Qualité 2	Qualité 3	Qualité 4	Qualité 5-6
Peau	Mucus	Transparent	Laiteux	Opaque	Goumeleaux	Jaunâtre épais
	Pigmentation	Couleurs chatoyantes	Couleurs vives	Couleurs ternies	Terne	Décoloré grisâtre
Oeil	Teinte	Pupille noire brillante	Pupille plus terne cornée transparente	Cornée opalescente	Pupille grise cornée laiteuse	Blanchâtre
	Affaissement	Bombé	Un peu affaissé	Plat	Concave au centre	Très concave
Branchies	Teinte	Colorée brillante	Moins colorée	Décolorée	Jaunâtre	Grisâtre
	Odeur	Spécifique neutre	Douceâtre	Faible rance	Légèrement putride	Putride (sulfuré ammoniacale) fétide
Rigidité	Chair	Ferme	Elastique	Souple	Molle	Flasque
	Paroi abdominale	Intacte	Détendue	Molle	Fragile	Perforée
Aspect de l'opercule	Pas de taches rouges (espèces démersales)	Légère coloration ou légère décoloration selon espèces	Apparition de taches rouges ou disparition suivant les espèces			Taches rouges ou disparition totale des taches suivant les espèces

2.4.2 L'opération d'adaptation des containers isothermes de 70 litres et 200 litres au niveau des structures de débarquement et de commercialisation du poisson[1]

L'étude de l'usage de containers isothermes au niveau des centres de pêche, des camions de transport du poisson glacé et des marchés, est en cours mais les résultats enregistrés sont très intéressants:

- l'étanchéité totale de ces contenants permet de conserver la glace en barres ou flocons pendant plus de 3 jours sans pertes notables. En outre, les échanges thermiques (très intenses au niveau du panier) se limitent au niveau des trous d'évacuation des eaux d'exsudation du poisson ou de fente de la glace;

- le poisson est mélangé à la glace en flocons ou concassée suivant des proportions (glace-poisson) se situant entre 0,35/1 et 0,50/1 kg contre un taux moyen de glaçage en paniers de 1 kg de glace pour 1 kg de poisson. En outre, la glace en flocons s'est avérée de manutention plus facile avec les containers isothermes et ne donne pas lieu aux pertes constatées lors du concassage des barres de glace;

- les pertes de glace sont faibles au cours du transport vers les zones d'écoulement contre plus de 70 % de glace fondue avec les paniers au bout de 5 à 8 heures;

- les qualités du poisson glacé au centre de pêche en containers isothermes sont maintenues telles pendant la période d'évacuation vers les zones d'écoulement; en outre, la durée de vie du poisson ainsi glacé au container isotherme est fonction de la qualité initiale du poisson frais avant glaçage.

Ainsi l'usage de ces containers isothermes permet aux mareyeurs de faire des économies de glace de 50 %, de présenter à la vente des produits de qualité uniforme et d'obtenir plus de profits nets de commercialisation. L'aspect du problème prix/qualité du poisson frais glacé et conservé en containers isothermes va être étudié. Toutefois, les industriels exportateurs paient déjà les prix d'achat du poisson frais glacé en fonction de la qualité des produits que présentent les mareyeurs; les problèmes d'usage de ces types de containers se réduisent à l'absence:

- de poignets pour soulever les contenants remplis de poissons et glace;

- de système de fermeture à clef pour se prémunir contre les vols.

2.4.3 Les centres coopératifs de mareyage CAPAS

La pesée, le lavage, la mise en froid efficace et le transport du poisson glacé en véhicules isothermes thermoking constituent les trois innovations technologiques importantes qu'offre ce système de mareyage qui pour réussir procède à différents aménagements dont:

- l'assainissement des coopératives de pêche afin de leur permettre de mener à bien la nouvelle fonction de commercialisation des captures;

- l'éducation et la formation coopérative des pêcheurs afin d'en faire de bons gestionnaires;

- l'étude et l'usage de camions à caisses isothermes sans thermoking (au coût de fonctionnement et d'entretien très élevé en zone tropicale).

D'ailleurs, la plupart des particuliers possédant des camions isothermes pour le transport du poisson frais de pêche artisanale, ont abandonné l'usage de thermokings au profit des véhicules à caisses isothermes uniquement.

2.4.4 Conclusions

Le container isotherme plastique, parfaitement adapté aux conditions locales de pêche et de mareyage peut à la fois:

- corriger l'irrégularité de la production en stabilisant l'offre de poissons frais au niveau des centres de pêche;

- constituer en tant que système de stockage un moyen de pression du pêcheur sur les mareyeurs;

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[1] cf. Projet FAO/CRODT: Amélioration de la conservation du poisson frais au cours du mareyage au Sénégal

- contribuer en tant que contenant à la place des paniers à la cessation de la déforestation des forêts de roniers; et
- offrir aux pêcheurs de meilleurs prix, et aux consommateurs de meilleurs produits.

3. RECOMMANDATIONS ET CONCLUSIONS

3.1 Au niveau de la production

Pirogues de pêche démersale:

Etudier et mettre en oeuvre une politique d'équipement des pirogues de pêche démersale en containers isothermes améliorés.

Pirogues de pêche pélagique:

(a) introduire l'usage de bâches ou couvertures fabriquées à base de matériaux locaux pour protéger les captures pélagiques du soleil et du vent avant l'introduction de containers;

(b) étudier l'aménagement de systèmes de conservation des captures à bord des pirogues afin que les pêcheurs puissent prolonger le temps de sortie en mer et continuer à ravitailler le marché intérieur.

3.2 Au niveau des plages de débarquement et aires de glaçage

- Etudier une politique des plages de débarquement et les aires de glaçage afin d'améliorer l'hygiène et les conditions de glaçage des captures;
- étudier et mettre en oeuvre une politique d'utilisation de containers isothermes amovibles comme structures de stockage de glace et de poissons glacés.

3.3 Au niveau de la commercialisation

(a) Etudier et mettre en oeuvre une politique d'utilisation de containers isothermes sur le camion de transport et au point de vente du poisson afin de parfaire la chaîne de froid;

(b) promouvoir une politique d'usage de véhicules de transport à consommation limitée de carburant et aptes à assurer la distribution des captures sans risques majeurs de pertes;

(c) amorcer une politique de commercialisation basée sur des normes de qualité et d'un système d'inspection du poisson frais.

3.4 Dans le cadre général de la pêche

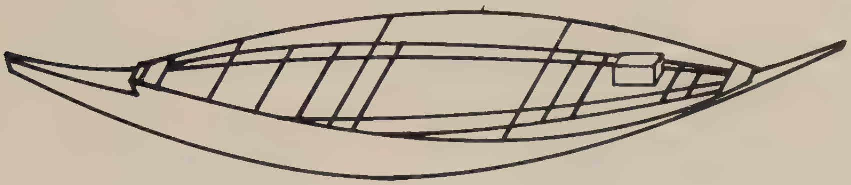
Les mesures d'accompagnement à la mise en place d'une parfaite chaîne du froid doivent porter entre autres sur:

- les possibilités d'économie de carburant et de glace depuis la capture jusqu'au point de vente du poisson;
- le ravitaillement du marché intérieur en poissons à privilégier au détriment de l'apport de devises par l'exportation de denrées dont les populations locales ont largement besoin.

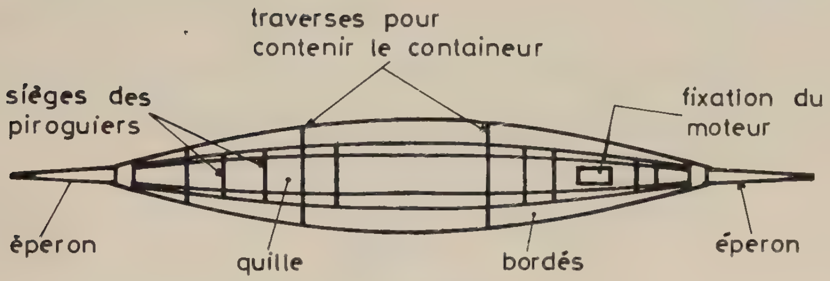
4. REFERENCES

Chaboud, C., 1982 Le mareyage du poisson frais au Sénégal. Doc.Sci.Cent.Rech.Océanogr.Dakar-Thiaroye/Inst.Sénégal.Rech.Agric., (94)

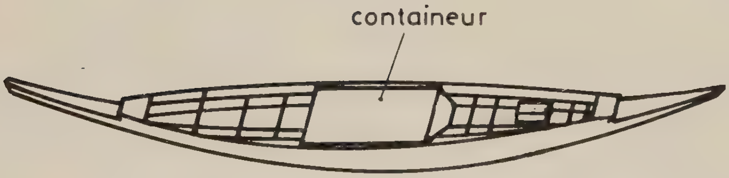
Schéma 1 La pirogue à containeur



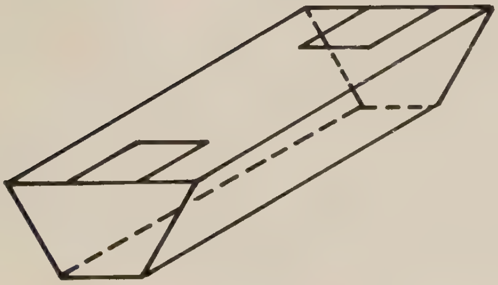
Vue en perspective


traverses pour
contenir le containeur
sièges des
piroguiers
fixation du
moteur
éperon
quille
bordés
éperon

Vue de dessus


containeur

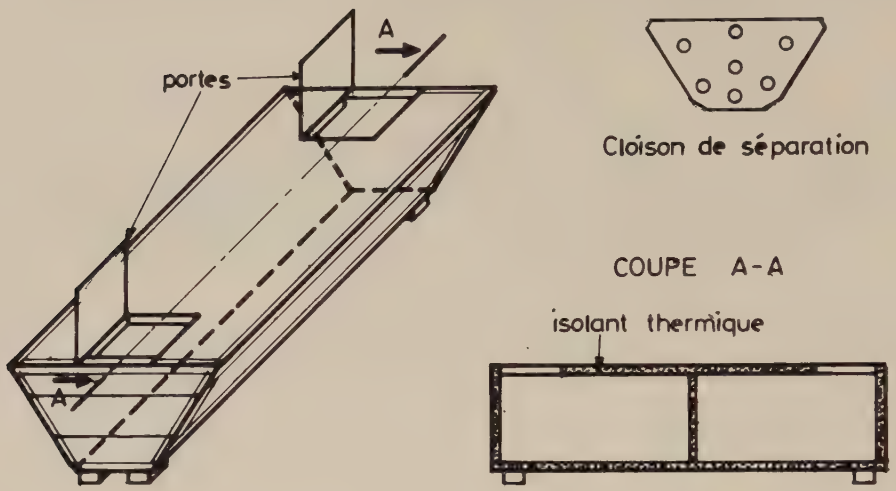
Pirogue à containeur (vue d'ensemble)



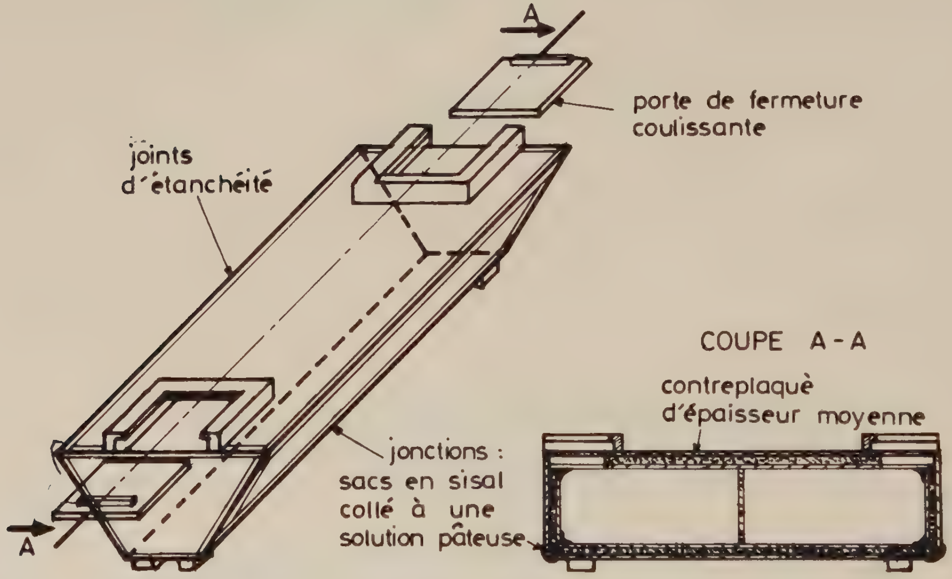
Containeur artisanal
nouveau modèle.

La forme et les dimensions du containeur suivent la forme de la pirogue.

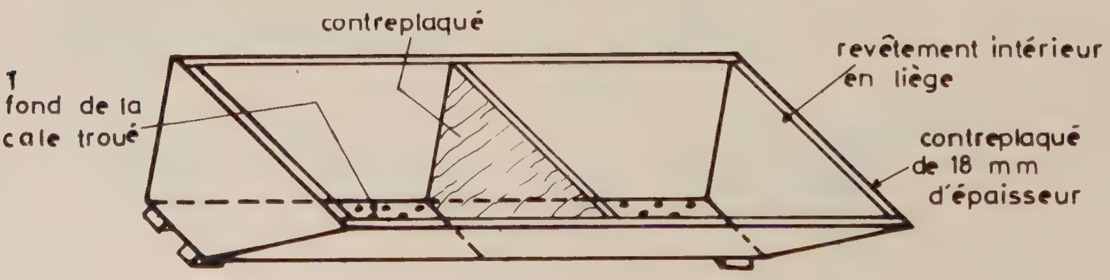
Schéma 2 Les containeurs artisanaux à pirogues


A
portes
A
Cloison de séparation
COUPE A-A
isolant thermique

2 - a - Containeur artisanal ancien modèle caractérisé par :
- des chutes de contreplaqué de très faible épaisseur
- des jonctions mal faites pour assurer l'étanchéité

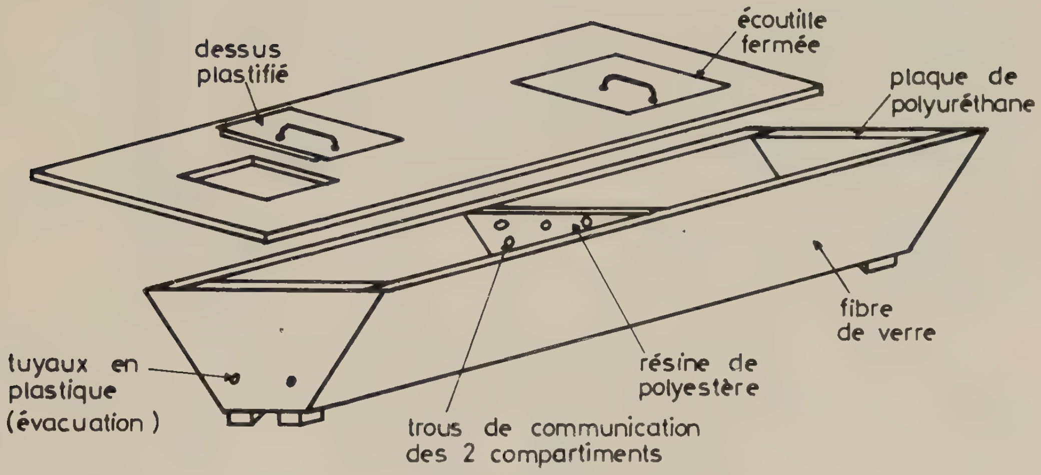

A
porte de fermeture coulissante
joints d'étanchéité
COUPE A-A
contreplaquè d'épaisseur moyenne
jonctions : sacs en sisal collé à une solution pâteuse
A

2 - b - Containeur artisanal nouveau modèle à base de contreplaqué et fond verni

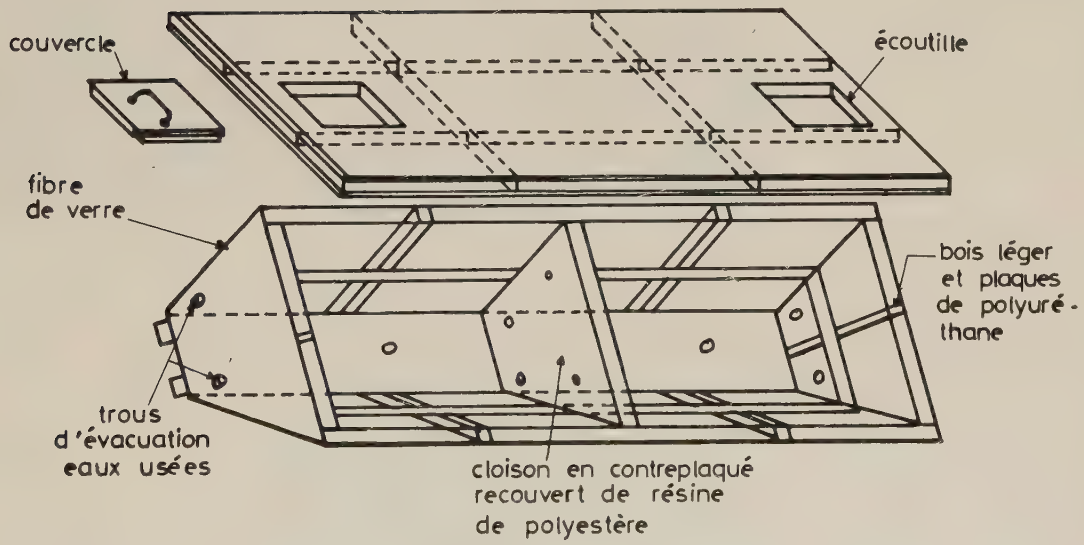

contreplaqué
fond de la cale troué
revêtement intérieur en liège
contreplaqué de 18 mm d'épaisseur

2 - c - Vue intérieure et caractéristiques d'un containeur artisanal

Schéma 3 Les containeurs améliorés

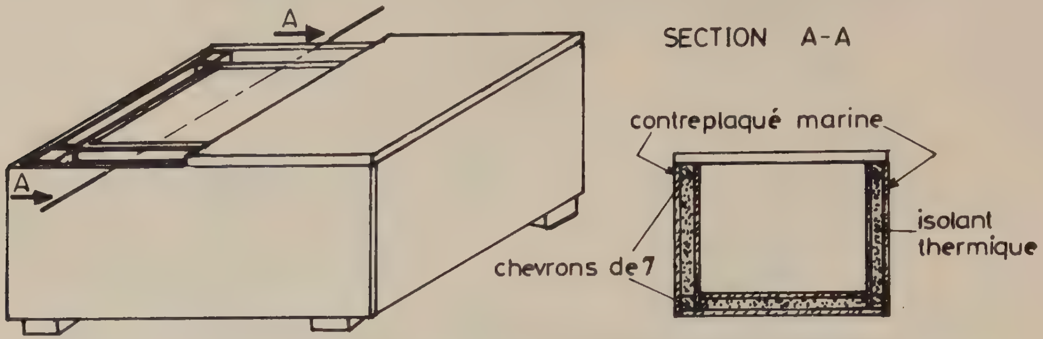

écoutille fermée
dessus plastifié
plaque de polyuréthane
fibre de verre
résine de polyestère
tuyaux en plastique (évacuation)
trous de communication des 2 compartiments

3 - a - Containeur amélioré n° 1.

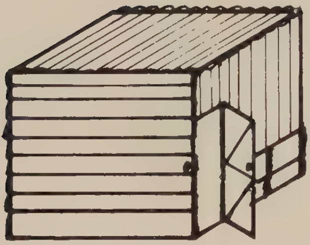

couvercle
écoutille
fibre de verre
bois léger et plaques de polyuréthane
trous d'évacuation eaux usées
cloison en contreplaqué recouvert de résine de polyestère

3 - b - Containeur amélioré n° 2.

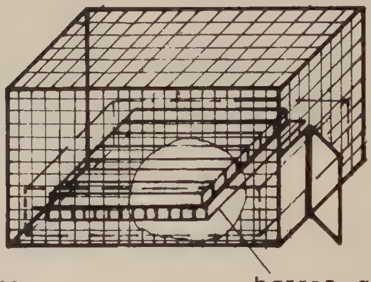
Schéma 4 Structures de glaçage et de commercialisation du poisson frais à Soumbédioune (Sénégal)


A
A
SECTION A-A
contreplaqué marine
isolant thermique
chevrons de 7

4 - a - Caisse de stockage poisson frais



4 - b - Caisse de stockage matériels de manutention


barres glace couvertes de sciure

4 - c - Hangar de stockage de barres de glace (en lambeaux de sacs ou en crinting)

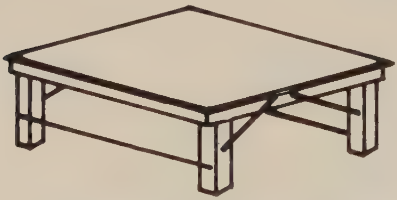
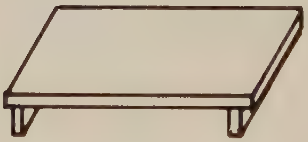


Table de vente de poisson frais

Bois pour écaillage

Couteau d'écaillage

Coupe-coupe de morcellement



Banc pour s'asseoir

4 - d - Structures de préparation et de commercialisation.

4 - e - Autres caractéristiques des structures artisanales de commercialisation :

Divers matériels sont aussi utilisés : carcasses de vieux congélateurs seaux en plastique pelles bols.

Le lavage se fait quelquefois à l'eau de mer.

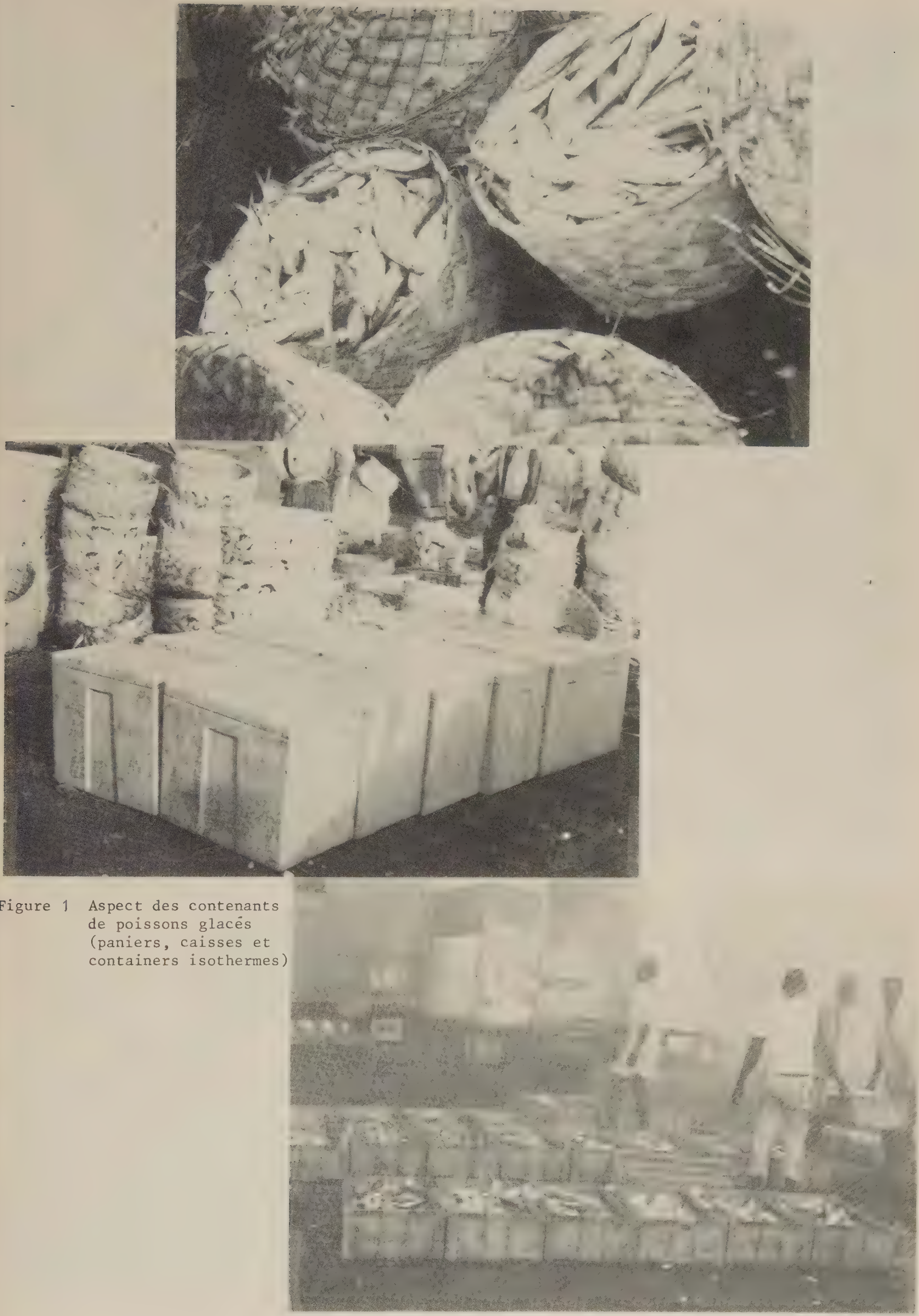


Figure 1 Aspect des contenants de poissons glacés (paniers, caisses et containers isothermes)

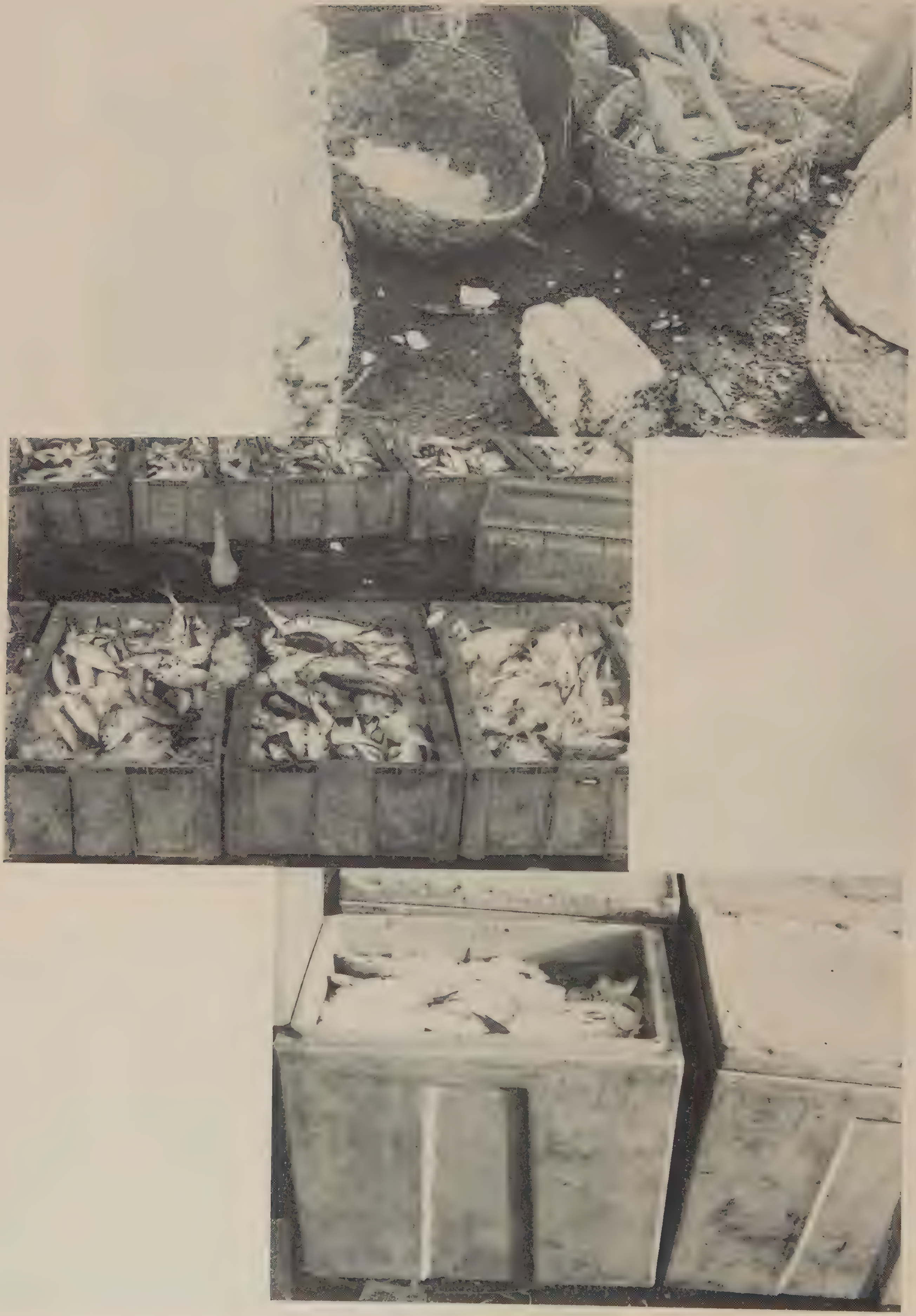


Figure 2. Conditions de glaçage du poisson frais et aspect du poisson glacé dans les paniers et les caisses et les containers isothermes

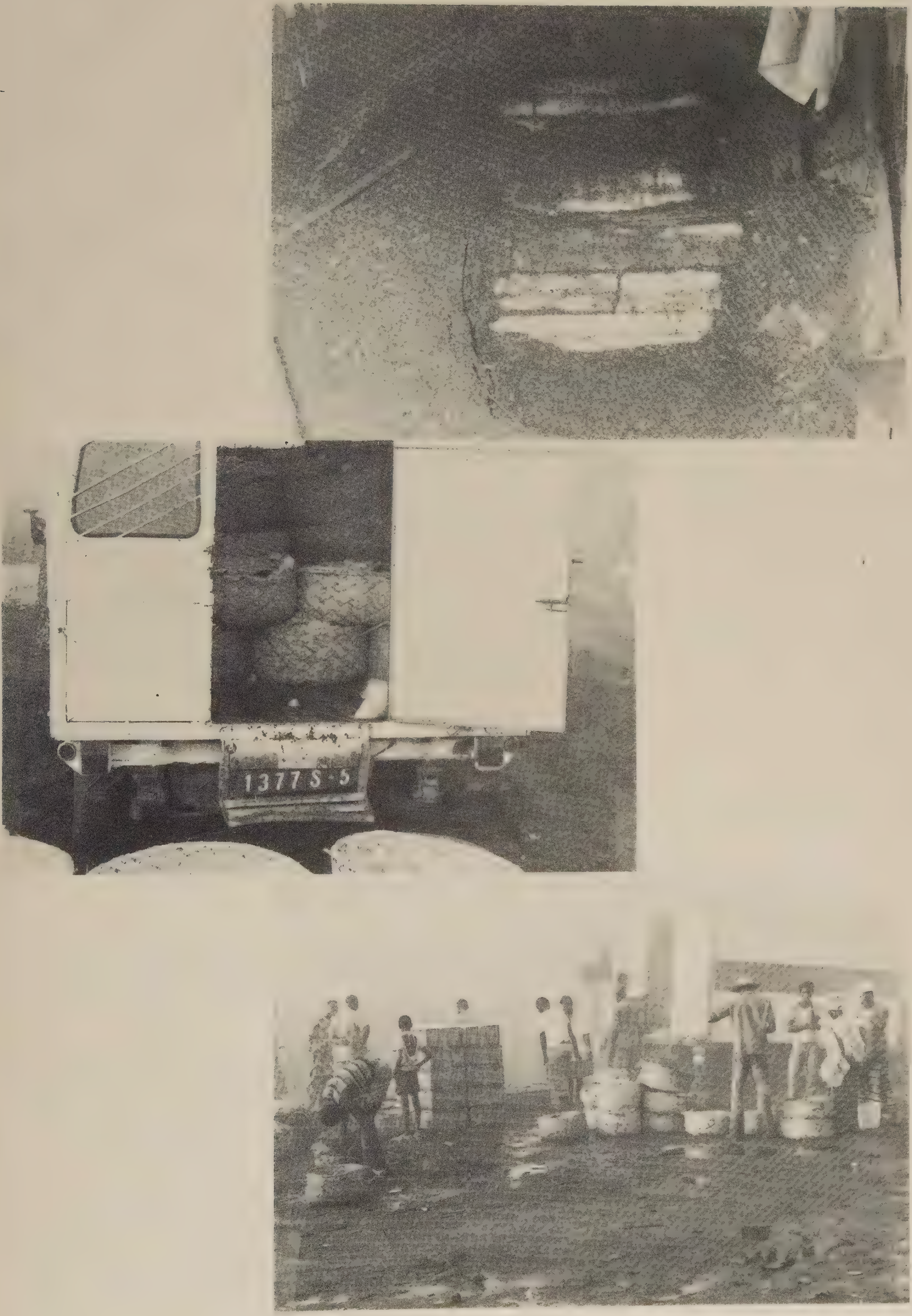


Figure 3 Aspect des 3a: structures de barres de glace; 3b: des véhicules de transport du poisson glacé; 3c: aires de glaçage

SESSION 2:

PROCESSING METHODS AND PRODUCTS CHARACTERISTIC/ METHODES DE TRAITEMENT ET CARACTERISTIQUE DES PRODUITS

THE CHORKOR FISH SMOKING METHOD: A TRULY APPROPRIATE TECHNOLOGY

by

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ABSTRACT

The Chorkor fish smoking technology has proven over the years (since it was developed in 1970, with the help of a small FAO project) to be far more efficient in terms of costs and energy utilization than other designs used in West Africa. With support from the Voluntary Fund of the UN Decade for Women, UNICEF and FAO, this method is slowly spreading to other parts of the region. Local extension agents have been trained and a "how-to" manual has been distributed. The ovens are made of clay mud which is available everywhere, and construction is done by local masons and carpenters. Up to 15 trays filled with fish are stacked on a rectangular oven (10-15 kg of fish per tray). Smoke and heat are contained within the "chimney" of trays, which is covered at the top. Fish are thus smoked rapidly and uniformly with a minimum of handling involved. When properly stored and occasionally re-smoked lightly, this product can be stored for up to 9 months in the tropics.

1. BACKGROUND

The year 1970 marked the beginning of a quiet revolution in fish smoking in West Africa. The women of Chorkor, Ghana, assisted by a small FAO project and the Food Research Institute of Accra, started using stackable trays on their traditional smoking ovens. A few progressive women fish smokers at Chorkor realized that this small modification made their work much easier and reduced their production costs. Gradually, the technology spread throughout the village, and by 1978 most fish smoking in Chorkor was done on the improved ovens. As of 1980 a few daring women from surrounding villages had built Chorkor-type smokers in their homes.

By 1983 there were over 400 improved fish smoking ovens in operation at Chorkor, but the concept was slow to spread to other villages. Meanwhile, the Chorkor women through 14 years of experience, had made numerous important improvements on the system. Though the Chorkor smoker was still virtually unknown outside the Greater Accra region, it was obvious that this was the most appropriate fish-smoking technology available for Africa, and that a concerted effort should be made to spread it around.

First, the UN Voluntary Fund for the Decade of Women (VFDW) agreed to finance a project in Guinea (Conakry) to introduce the Chorkor concept there. Then the Ghana office of UNICEF provided funding for a small extension effort in eastern Ghana, plus the publication of a practical, graphic manual showing how to construct and operate a Chorkor smoker. The first three ovens were built in Conakry in October 1983. They were an immediate success, and have been used regularly ever since (even before official start-up of the project).

Eight pilot ovens were built in different locations in Ghana in September, and by March 1984 there were 110 new ovens built, almost entirely on the initiative of individual women.

Ever since the early 1950s there have been numerous attempts to build improved ovens with trays for fish smoking in Africa. Various designs were developed using 200-litre steel drums. Some are still in use, but most were abandoned because they all are cumbersome to work with, and they usually rust after one year's use. The drums are also becoming scarce and expensive in Africa. The Altona oven and others made from sheet metal (usually with a brick or cement firebox) have all proved to be too costly and difficult to maintain, plus they require a complete change of women's fish-smoking habits. The Ivory Coast kiln and the Watanabe oven (Watanabe, 1975) were the best of the other improved ovens of the 1970s, but they never caught on due to lack of extension work and high costs of construction and maintenance.

2. ORIGINS OF THE TECHNOLOGY

The Chorkor smoker grew out of the traditional cylindrical West African oven made from packed clay mud. This form is still widely used, but it is extremely inefficient. It can accommodate only 1-3 layers of fish supported on sticks. The sticks bruise, bend, and partially cover the fish. The women must constantly change the position of the fish and the sticks, while leaning over the oven and having heavy smoke in their eyes. This tedious procedure yields only 10-20 kg of low-quality smoked fish after at least 10 hours of work spread over two days.

This cylindrical form was modified into a rectangular oven by many fish-smoking women in the 1960s when rolls of wire mesh became readily available on the local market. The women used rectangles of "wire nets" the size of their ovens, and spread their fish upon them; then they placed several layers on the ovens, separated by sticks and supported by several iron rods spanning the top of the open oven. This was an improvement, but the fish continued to be damaged and unevenly smoked, and there was only a slight reduction in the amount of labour and firewood required.

The introduction of a simple wood frame to hold the wire mesh made all the difference. The resulting trays fit closely together and up to 15 fish-filled trays can be stacked on top of each other, thus forming a perfect chimney, usually covered at the top. This technique causes nearly all of the heat and smoke to be retained and to circulate among the layers of fish.

3. ADVANTAGES

(a) The Chorkor system has proven to be in keeping with the fish smoking habits of West African women, so no major adaptation or re-education is necessary;

(b) low construction cost (US$ 100 to US$ 175 for a double oven with 15 trays, depending on the availability of framing boards and wire mesh);

(c) long life and low maintenance if well-protected from the rain;

(d) large capacity - up to 240 kg of wet fish can be smoked at a time;

(e) high quality and uniformity of product;

(f) easy to operate (much less time and effort involved; the smoke-box, top of oven, and trays are all very accessible);

(g) no smoke in the eyes, and

(h) greatly reduced consumption of fuel (6-10 times less fire-wood required than with the traditional ovens).

4. CONSTRUCTION

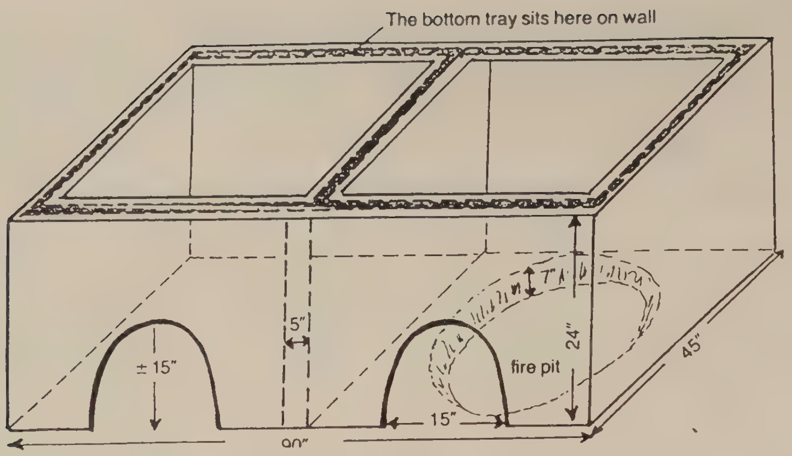
4.1 Ovens

4.1.1 General design

The ovens are rectangular, about twice as long as wide, with two stoke holes in front. Preferably there is a foundation sunk in the ground and a dividing wall in the middle, both being recent improvements on earlier models.

The advantages of middle wall are:

- it gives added strength to the oven;
- protects the median cross piece of the bottom tray from burning;
- gives greater support to the loaded trays;
- allows for smoking of small quantity of fish over just one chamber, using less wood.



4.1.2 Materials

There are four appropriate approaches for construction of smoking ovens:

(a) clay mud, packed and shaped by hand (85-95 "headloads" or basins for one oven);

(b) packed clay mud faced with cement (1/2 bag);

(c) clay mud blocks (sun dried or baked) and mortar, and

(d) cement blocks with mortar (requires 3-4 bags of cement and sand that is well washed).

Wire nets of 1/2 inch to 1 inch mesh and 18-20 gauge are required (though often bigger meshes and finer gauges are accepted, if nothing else is available). These normally come in rolls of 1 x 50 (yards or metres), enough for 22-25 trays.

About 50 nails are required to frame a tray and batten down the wire net.

4.1.3 Procedures

The three cross pieces are butted inside the two long members (which normally terminate in handles). By nailing these together the basic frame is made.

Two 70-cm (2 1/2 inches to 3 inches) nails are used at each of the six joints of the smoking trays (width of boards: 5.5 cm, or 2.2 inches). Three or four nails are used for the wider (15 cm, or 16 inches) storage tray boards at each joint.

The wire nets are cut to the size of the frames and attached to the under side with small nails. Then the 1 cm (1/2 inch) battens are nailed to the bottom edges of the frames to hold the nets firmly in place.

4.1.4 Key points of design

(a) The trays must be square and fit flush together in order to form a proper "chimney";

(b) the nets must be stretched in both directions across the bottom of the frames in order to support 15 or more kg of fish per tray, and

(c) the frames can last as long as three years and the nets for two if the trays are properly constructed and maintained:

- avoid burning and scorching;
- apply vegetable oil regularly to nets;
- avoid reckless handling and bumping;
- cover to protect from sun and rain.

4.2 Trays

4.2.1 General design

The Chorkor smoker is designed so that the wooden frames of the trays will rest along the midlines of the oven walls (thus, they are firmly supported and will not catch fire). For each oven there should be 12-15 smoking trays, plus several deeper storage trays.

4.2.2 Materials

Ideally, hardwood planks (such as odum) should be used for tray frame construction (greater strength; resistance to heat, moisture, insects). In practice, however, softwoods (primarily wawa) are used almost exclusively because they are 2-4 times less expensive.

4.2.3 Procedures

(a) The ground is cleared and levelled; the outline of the oven walls is drawn; a trench 6-8 inches deep is dug for the foundation;

(b) preparation of materials (delivery of clay soil or blocks); if loose clay, it is mixed with water and pounded until it becomes malleable and sticky;

(c) construction of walls in layers (if clay mud, it is done in three stages: first, the lower half is packed and allowed to dry, then about 40% more, and finally the upper surface is packed and squared). Three days for packed clay ovens, two days for block construction;

(d) for the clay oven, the stoke holes are cut in the front wall once it is dry (with any sharpened strip of iron); the area to be cut must first be wetted;

(e) for the cement oven, an arch is made with a piece of scrap plywood, and packed with cement well bonded to the blocks surrounding it, and

(f) the last step is plastering (with clay or cement) after the oven and stoke holes have dried.

4.2.4 Key points of design

(a) The top of the oven must be square, level and flat, so that the wooden-framed trays can rest flush upon the walls;

(b) the stoke holes should be arched for greater structural strength, and large enough for stoking and removing wood (but not so large as to permit heat and smoke to escape), and

(c) the oven should be low (for ease of stacking up to 15 trays), but the fire should always be at least 20 inches from the lowest tray, so a 4-8 inch fire pit should be dug for each stoke hole.

5. CONCLUSIONS

Most innovative ideas for increasing food production in the developing world are immediately met with innumerable obstacles. New technologies are often too complicated or require too much maintenance to be accepted by the producers. Supporting services like repair shops and supply stores are either inadequate or totally lacking. Few of the necessary tools and materials are made locally, and the costs of most imported goods put them out of reach of the producers. Companies, farms or fishing groups organized and managed by governments usually fail due to gross inefficiency.

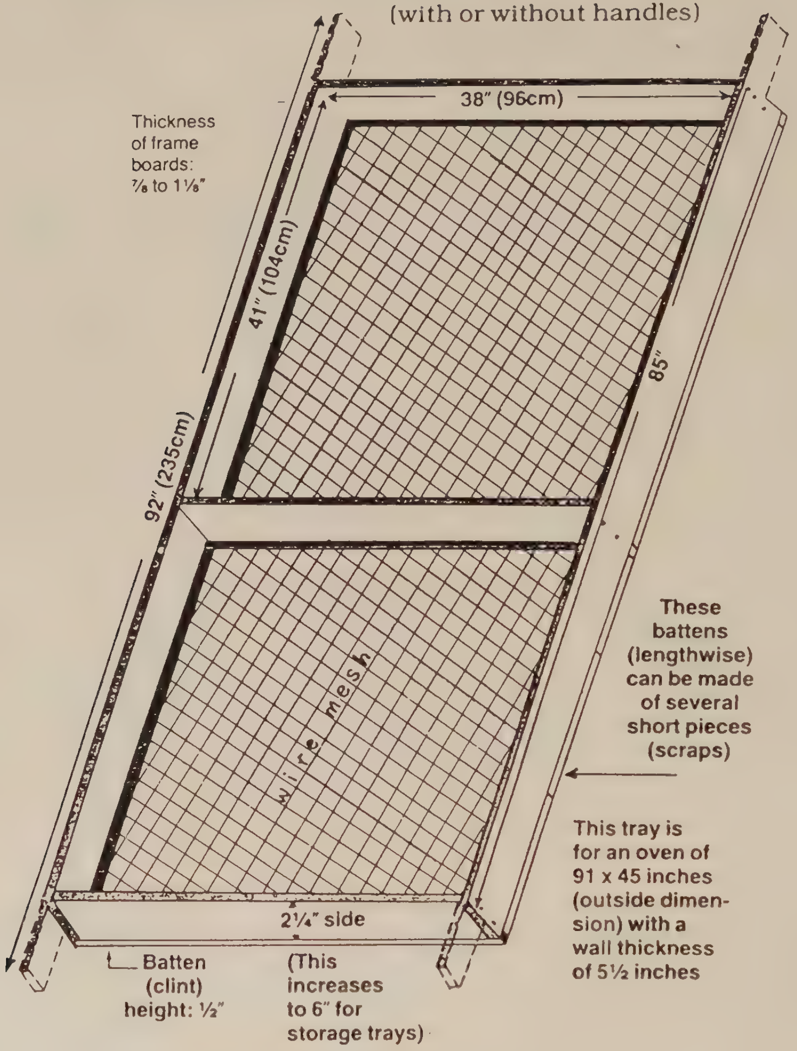
The Chorkor fish smoking technology, however, depends only on fairly regular supplies of fish, fuel (mainly hardwood and coconut husks), and periodic availability of wire nets, lumber, and nails to rebuild the trays when they wear out. Because of the high storage potential of the smoked fish, short-term marketing problems, such as broken-down trucks and washed-out roads are usually not serious limiting factors (in fact, most of the fish is either marketed locally or stored in anticipation of the best marketing opportunities). Technology transfer is not a problem, as the new users can be instructed in three or four one-hour sessions how to build and operate the smokers and the storage system (thus, all the extension work necessary to establish the Chorkor system in 6-12 villages can be accomplished in 3-4 months).

The Chorkor ovens are built with local materials. The materials for trays are usually easy to obtain. The quality smoked fish at a reasonable price is always in high demand. It is still one of the cheapest (and often the only) sources of protein, and taste-wise is one of the most desired foods in West Africa.

It is a great advantage for the women to smoke fish at home, so that they can tend to their numerous other chores at the same time (and the new techniques require much less of their attention than with the traditional system).

This technology is rapidly spreading around Ghana and Guinea, and it is soon to be introduced through a VFDW project in Togo. Most likely, the on-going fish-smoking projects in Benin and the Ivory Coast will soon adopt the Chorkor system. The Gambia and Guinea Bissau have recently requested projects to help set up Chorkor smokers. The success of this technology is due to the fact that it was developed by the people themselves to satisfy important felt needs.

TOP VIEW OF SMOKING TRAY


(with or without handles)
38" (96cm)
Thickness of frame boards: ⅞ to 1⅛"
41" (104cm)
85"
92" (235cm)
wire mesh
These battens (lengthwise) can be made of several short pieces (scraps)
This tray is for an oven of 91 x 45 inches (outside dimension) with a wall thickness of 5½ inches
2¼" side
Batten (clint) height: ½"
(This increases to 6" for storage trays)

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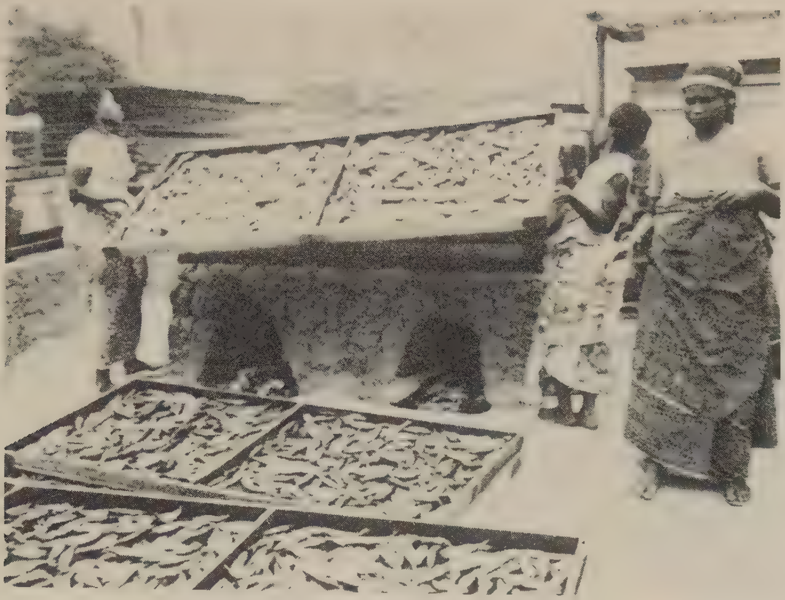

Figure 1 Changing the order of trays during the smoking of Sardinella at Chorkor (note the ovens and stacks of trays, including some of the thicker storage trays in the background)

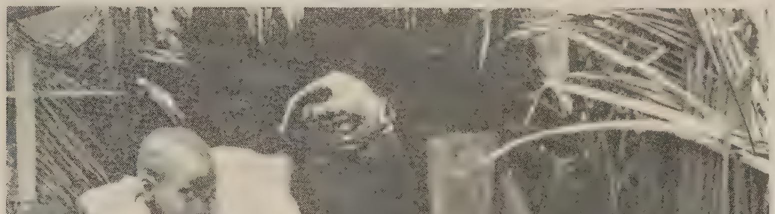

Figure 2 Traditional smoking of Sardinella on a one-layer, double-drum smoker, Keta area

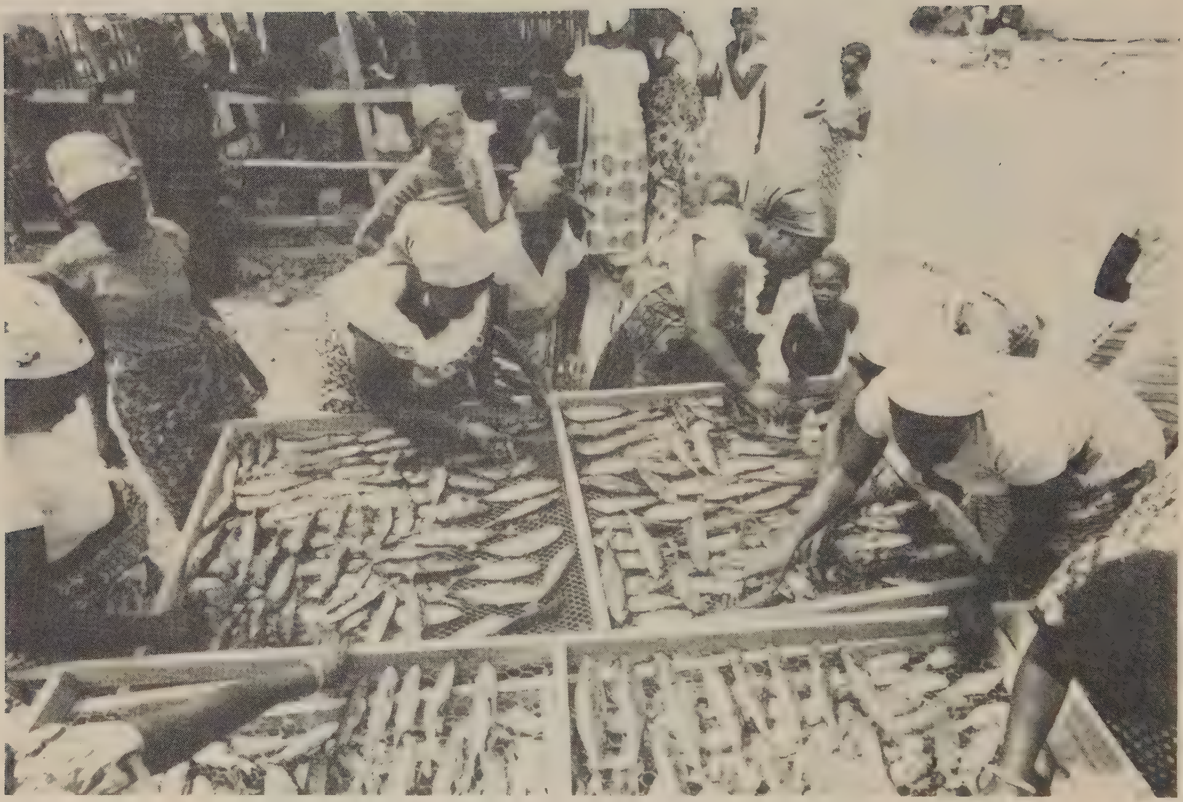

Figure 3 Tunas, herrings, anchovies being smoked as part of a fish-smoking workshop. Teshie, Ghana, March 1984

OBSERVATIONS SUR LE FONCTIONNEMENT DES FOURS "CHORKOR"

par

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RESUME

Les fours Chorkor tirent leur nom de la région dans laquelle ils sont conçus et très usités. L'auteur de ce document fait ici ses observations sur le fonctionnement desdits fours et suggère quelques modifications en vue de les rendre plus performants.

1. INTRODUCTION

Pour l'Afrique en développement, l'essor des technologies appropriées aux milieux rural et urbain est une priorité; ceci a été compris très tôt par les femmes transformatrices de poisson de la région de Chorkor (Accra) qui ont conçu et amélioré progressivement un système de fours qui tirent aujourd'hui leur nom de cette région: les fours Chorkor.

Notre séjour au Ghana, à l'occasion du séminaire sur le fumage du poisson qui s'est tenu du 13 au 15 mars 1984, nous a permis de les connaître et de les apprécier. Mais le système n'a pas que des mérites. Il présente certaines insuffisances; la présente étude se veut une modeste contribution à l'amélioration du système afin de le rendre plus performant.

2. DESCRIPTION DU SYSTEME CHORKOR

2.1 Aspect général

Ce sont des fours rectangulaires à peu près deux fois plus longs que larges avec une séparation au milieu dans le sens de la largeur et deux ouvertures semi-circulaires à l'avant donnant sur les foyers. Dans chaque foyer il y a un trou ou "creux de feu" circulaire de 20 à 30 cm de profondeur destiné à augmenter la distance entre le feu et la première couche de poissons (on n'utilise pas dans ces fours de répartiteur de chaleur)(voir figure 1).

Il convient de noter que ces dimensions ne sont pas fixes et varient d'un four à un autre.

2.2 Matériaux de construction

La plupart des fours sont construits en argile avec ou sans crépissage extérieur en ciment. De l'avis des femmes de Chorkor la couche de ciment servirait de protection contre la pluie et augmenterait la durée d'utilisation desdits fours (évaluée à huit ans pour les fours recouverts d'une couche de ciment, et à quatre ans pour les fours sans revêtement extérieur).

2.3 Fonctionnement

Après la préparation, les poissons à fumer sont disposés sur des claies rectangulaires qui sont posées les unes sur les autres. On superpose jusqu'à 15 claies (voir photos 1 et 2). Le changement de position des claies n'est pas dicté par le temps d'exposition du produit au feu.

En général, les femmes examinent une claie située au milieu puis les deux dernières, et jugent de l'opportunité de procéder à la rotation des claies qui sont alors déposées à même le sol (voir photo 3). On procède alors au retournement des poissons qui se fait à la main lorsqu'il s'agit de gros individus, et par un transvasement des claies chargées de poissons vers des claies vides lorsqu'il s'agit de petites espèces (fretin).

Le processus de fumage, suivant les espèces et leurs tailles, et en fonction de la durée de conservation souhaitée, peut durer de quelques heures à trois jours.

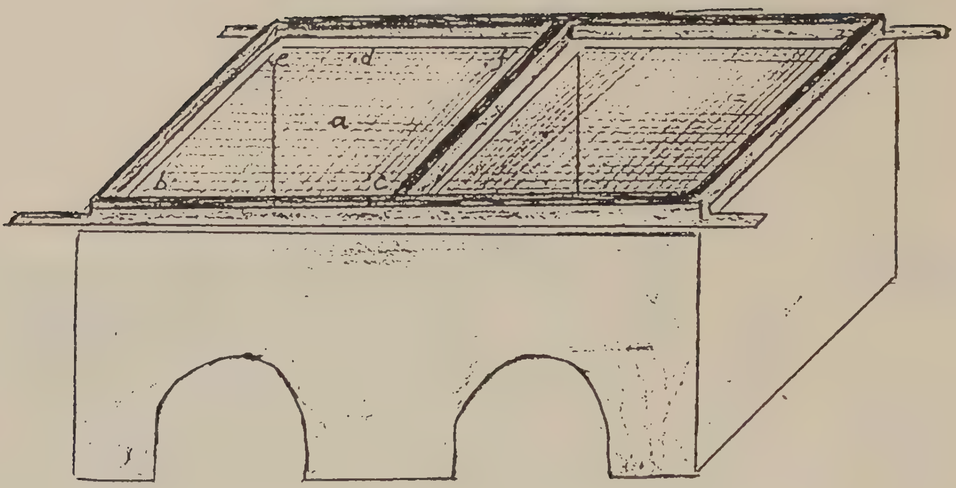

Figure 1 Dimensions: longueur: 2,3 m
largeur : 1,14 m
hauteur : 0,65 m

Après le fumage le produit est déversé dans des claies de stockage (dont les bords sont plus hauts que ceux des claies de fumage), qui sont empilées les unes sur les autres, disposées sur des blocs et soigneusement enveloppées de bâches plastiques recouvertes d'une feuille de contre-plaqué (voir photo 4).

Enfin, du point de vue coût, l'investissement dans un four, incluant les claies de fumage et de stockage peuvent avoisiner la somme de FCFA 80 000 environ dont FCFA 57 000 pour les fours et les claies de fumage.

3. MERITES DU SYSTEME

A. Le système a été conçu et amélioré progressivement par les femmes suite à plusieurs années d'expérience dans le domaine; il n'a été ni importé ni imposé par un quelconque projet d'assistance et en tant que tel est parfaitement accepté dans le milieu.

B. La manipulation est rendue plus facile (en particulier pendant la rotation des claies) grâce à l'introduction de grillage avec cadres en bois.

C. Le système est très souple, et adaptable aux quantités à traiter par:

- la mise en service d'un compartiment ou deux du même four;
- la mise en service de plusieurs fours à la fois;
- la superposition de plusieurs claies sur un même four.

D. Le cadre de bois de la première grille repose sur la moitié de l'épaisseur des murs et dans cette position n'est pas touché par le feu.

4. LES INSUFFISANCES DU SYSTEME

4.1 Installation

A. Les fumoirs sont installés pêle-mêle et leur orientation ne tient pas toujours compte de la direction du vent dominant, ce qui rend les conditions de leur exploitation plus difficiles. (Dispersion de la fumée, difficulté de réglage de l'intensité de la flamme, etc.).

B. Ils ne sont pas abrités, ce qui ne permet pas de travailler quelles que soient les conditions atmosphériques. Le système de protection qui consiste à les recouvrir avec des feuilles de tôle ou de la toile cirée en cas de pluie nous paraît trop fastidieux et même inefficace. En effet, s'ils sont protégés contre une destruction par le haut, ils ne le sont pas pour autant contre les effets de l'eau de ruissellement qui les érode, réduisant ainsi la durée de leur utilisation. Ainsi donc la durée d'exploitation de quatre à huit ans qu'on leur concède dans la brochure "Guide pratique pour l'amélioration du fumage du poisson en Afrique de l'Ouest" nous paraît excessive. De même le crépissage superficiel des fours avec du ciment sous prétexte qu'il le protège contre la pluie n'est pas à notre avis une solution très efficace dans la mesure où le ciment adhère difficilement à l'argile et s'écaille aux moindres chocs, inévitables dans ces conditions de travail (voir photo 5).

4.2 Fonctionnement et rendement énergétique

Comme nous l'avons mentionné plus haut l'orientation des foyers ne tient pas toujours compte de la direction des vents dominants; il en résulte une fuite importante de chaleur d'une part à travers les fissures des murs et les ouvertures, et d'autre part entre le bord supérieur du fumoir, pas toujours de niveau, et la première claie. Pour remédier à cette lacune les femmes utilisent des contre-plaqués ou des sacs de jute pour boucher les ouvertures par où passe la fumée, ce qui n'est pas toujours efficace (photo 6).

Les conséquences prévisibles qu'engendre une telle situation sont l'augmentation de la consommation de bois de chauffe entraînant à son tour une élévation du coût de production. Il est vrai, qu'à Accra le bois de chauffe ne coûte pas cher. Ceci n'est pas valable pour les autres pays de la sous-région.

Par ailleurs, la répartition de la chaleur dans les fours n'est pas uniforme; ce qui laisse supposer qu'il existe des zones "froides" à l'intérieur. Les résultats obtenus à la suite des prises de température en différents points des fours (voir figure 1, points a à f) et consignés dans les tableaux 1 et 2 sont à cet effet très parlants.

Commentaire des tableaux 1 et 2

Des résultats des tableaux 1 et 2, on peut déduire les points suivants:

(1) la chaleur se répartit de façon inégale dans le four;

(2) la cuisson ainsi que la déshydratation du produit en différents points des claies ne se font pas à la même vitesse, même pour des espèces de taille homogène. La rotation des claies fait changer le poisson de position sur une même verticale sans intervertir leur position par rapport à la répartition de la chaleur;

(3) la quantité de chaleur que reçoit le produit en un point donné de la claie diminue au fur et à mesure qu'on s'éloigne de la première claie; cette diminution s'accentue à partir de la cinquième claie. La question se pose de savoir quelle sera la température à la quinzième;

(4) les produits fumés dans ces conditions ne peuvent pas être homogènes et se conserver pendant la même durée. d'ailleurs une étude sur la densité de la fumée en différents points menée comme dans le cas de la mesure de température aurait sans doute permis de préciser cette constatation. (etude non réalisée faute de moyens).

En outre, on peut noter que pour que les produits soient uniformément fumés, il aurait fallu que les opérations de rotation des claies et de retournement de poissons puissent être menées avec la plus grande rigueur; or en disposant 15 claies ces opérations deviennent trop complexes et fastidieuses.

4.3 Stockage des produits

Le mode de stockage pratiqué à Chorkor à savoir: 'Claies chargées de poissons fumés, empilées les unes sur les autres, bâchées et recouvertes d'une feuille de contre-plaqué pour assurer une bonne conservation pendant six mois ne convient pas. En effet, compte tenu des variations de température et d'humidité à différents moments de la journée et de la nuit, la bâche de plastique ne peut empêcher la formation de condensation et le relèvement de la teneur en eau des produits. La formation des moisissures ou le déclenchement de tout autre processus de dégradation sont donc inévitables à plus ou moins brève échéance. Il est donc impossible de conserver le produit six mois d'affilée à moins de procéder régulièrement au refumage du produit ou à l'admission d'un courant de fumée à travers le dispositif.

4.4 Hygiène

A. Les fumoirs ne sont pas contigus et les femmes sont obligées de poser les claies à même le sol lors de la rotation des claies, ce qui ne paraît pas très hygiénique (voir photo 3).

B. Le stockage des produits sur des claies autres que celles utilisées pour le fumage nous paraît également peu hygiénique; les grilles se corrodent sous l'effet des embruns et l'oxyde de fer peut contaminer les produits.

4.5 Aspect économique

Le prix de revient du système n'est pas négligeable compte tenu de sa durée d'exploitation: les grillages utilisés (grillage de poulailler) pour la fabrication des claies ne sont pas très résistants, se corrodent très vite et par conséquent doivent être constamment renouvelés.

5. PROPOSITIONS POUR UNE AMELIORATION DU SYSTEME

5.1 Forme, dimension et disposition

A. La forme rectangulaire facilite l'utilisation des claies, qui rendent la manipulation plus facile, et à ce titre doit être maintenue.

B. Pour une meilleure concentration de la fumée et dans le souci de réduire le nombre de zones froides, vers la périphérie et que nous avons signalées, on pourrait réduire les dimensions des fumoirs. Nous suggérons à cet effet les dimensions ci-après:

2 m x 1 au lieu de 2,30 m x 1,14 m

Des essais seraient à mener pour étudier l'influence des dimensions des fumoirs sur la répartition de la chaleur à l'intérieur des fours.

C. Pour limiter la déperdition de la chaleur, il importe d'orienter les foyers en tenant compte de la direction des vents dominants.

D. L'existence de zone "froide" surtout vers la périphérie peut également être attribuée à la forme géométrique et au diamètre du "creux de feu" destiné à augmenter la distance entre le feu et la première couche de poissons. Nous suggérons que celui-ci soit de forme rectangulaire ou carrée, de dimensions de juste inférieures aux dimensions intérieures du four (3 à 4 cm).

E. Enfin, la contiguïté des fours pourrait permettre aux femmes d'effectuer les opérations de rotation de claies dans des conditions plus hygiéniques: les claies chargées seront déposées sur les fours non occupés au lieu de les déposer par terre.

5.2 Matériaux de construction

Pour réduire le coût de construction, et afin de laisser à ces fumoirs toute leur originalité, on devra surtout faire appel à du matériel local et non à du matériel importé. C'est pourquoi nous suggérons que ces fumoirs soient uniquement en argile, sans crépissage en ciment. Au début de chaque saison, les femmes pourraient, pour supprimer les fissures, procéder à un crépissage extérieur en mélangeant un peu de sable de plage à de l'argile bien pétrie.

Par ailleurs, afin d'augmenter leur durée d'exploitation et de permettre aux femmes de travailler quelles que soient les conditions atmosphériques, il est nécessaire que les fumoirs soient abrités; nous suggérons à cet effet un hangar à double toit construit entièrement en matériaux locaux (voir figure 2) qui présente le grand avantage de laisser échapper la fumée grâce à l'espace libre compris entre les deux toits. Il est vrai que le coût d'un tel hangar n'est pas négligeable mais l'union faisant la force plusieurs propriétaires de fumoirs pourraient s'associer pour réaliser un tel ouvrage.

5.3 Fonctionnement

Pour que les poissons, quelle que soit leur position sur une claie de rang donné, puissent recevoir le minimum de chaleur nécessaire à leur cuisson et à leur déshydratation, le nombre maximum de claies que l'on pourrait recommander ne devrait pas excéder la dizaine (déperdition de chaleur en fonction de l'éloignement du feu).

5.4 Stockage des produits

Le stockage des produits fumés dans des paniers dont l'intérieur est préalablement garni de feuilles nous paraît moins onéreux et moins fastidieux; ceci ne nécessite pas la fabrication de claies de stockage dont le prix de revient n'est pas négligeable.

6. CONCLUSION

La réussite des opérations de fumage sur les fours Chorkor n'est pas due à notre avis à la qualité technique desdits fours mais trouve plutôt son explication dans le savoir-faire des femmes suite à plusieurs années d'expérience dans le domaine. Malgré les quelques suggestions en vue de leur amélioration, nous ne saurions recommander leur transposition à l'identique dans d'autres pays de la sous-région, où à notre avis, la performance d'un four doit être considérée de façon spécifique. Les conditions climatiques, les habitudes alimentaires, les espèces de poissons à fumer, les exigences de la clientèle et le coût de certaines matières premières sont en effet variables d'un pays à un autre.

Tableau 1

Variation de la température en °C en différents points du fumoir[a/]

Les positions	Températures relevées		
	1ère mesure	2ème mesure	3ème mesure
a	130	139,7	147
b	86	91,6	102,1
c	91	99	110,2
d	109,1	120	130
e	118	122	136
f	96	99	110,2

a/ Les mesures ont été effectuées avec un thermomètre électronique. Elles ont débuté 30 min après le démarrage du fumage et ont été répétées à une heure d'intervalle

Tableau 2

Variation de la température en fonction de la position des claies[a/]

Ordre de numérotation des claies	Températures relevées		
	1ère mesure	2ème mesure	3ème mesure
1	142,3	142,6	141
2	139,6	136	138,8
3	131	127	129,4
4	112	108	112,6
5	101	103	100
6	97	92	96
7	77,6	67	69

a/ Les points pris sur différentes claies se situent sur la même verticale et les claies sont numérotées dans l'ordre d'éloignement du feu

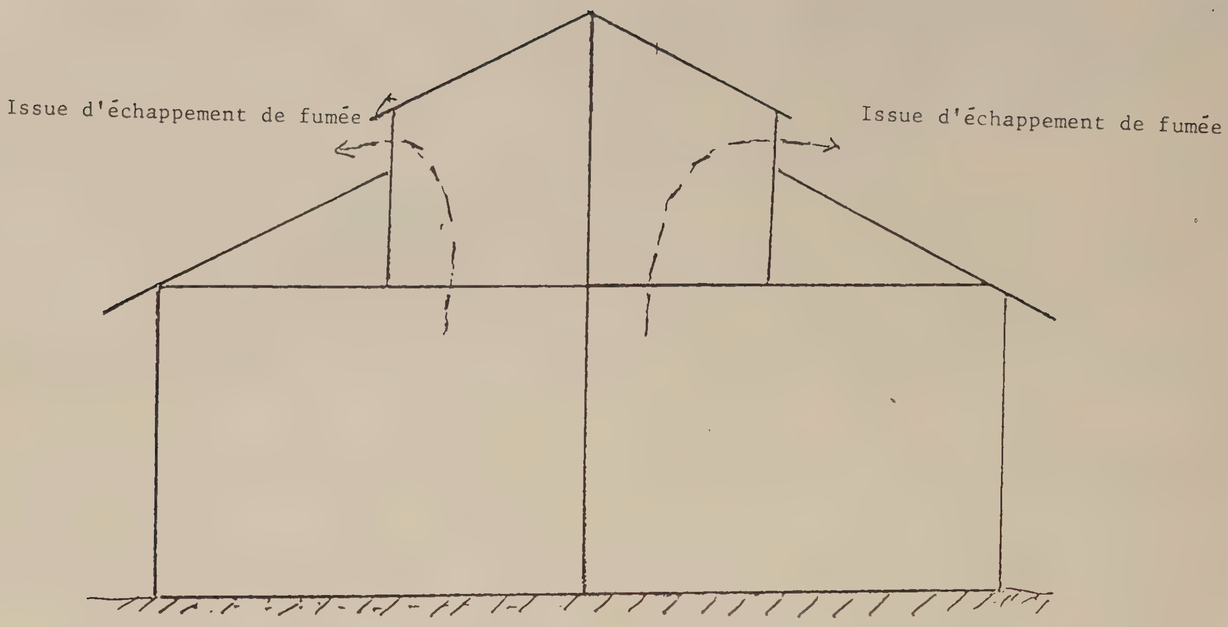
Issue d'échappement de fumée
Issue d'échappement de fumée

Figure 2 Schéma hangar de fumage
(vue de face)

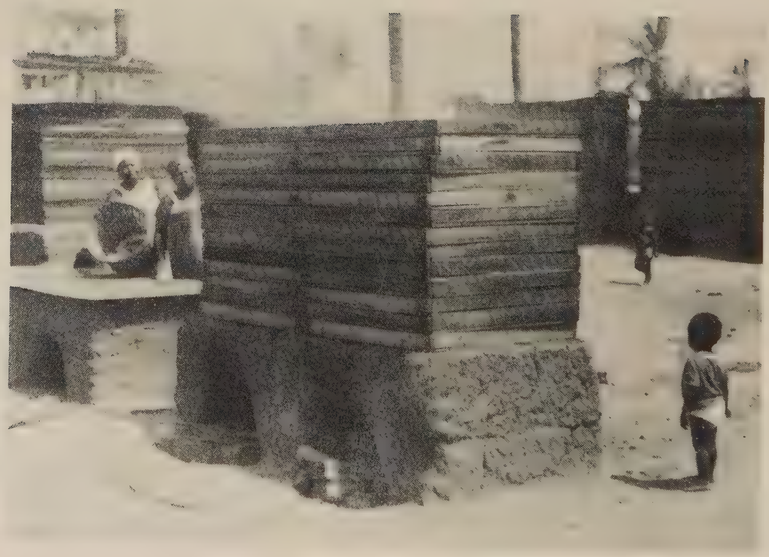

Photo 1 Superposition des claies

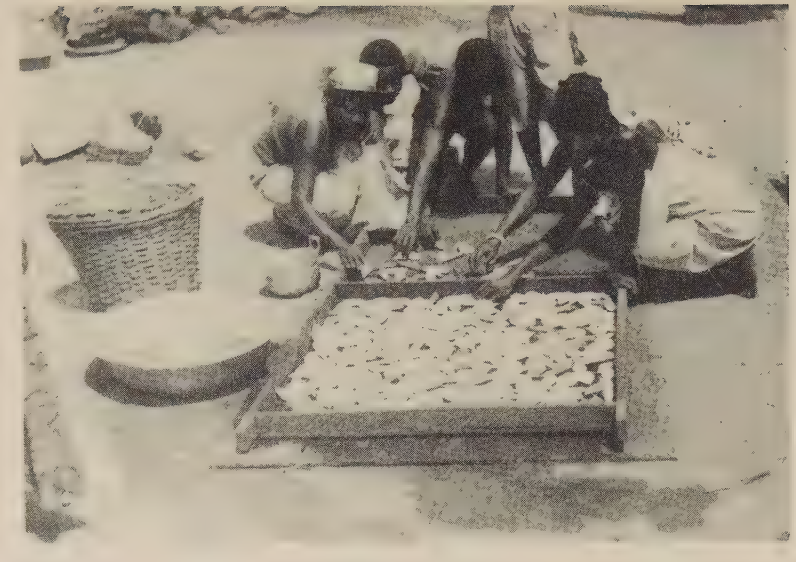

Photo 2 Disposition des poissons sur une claie de fumage

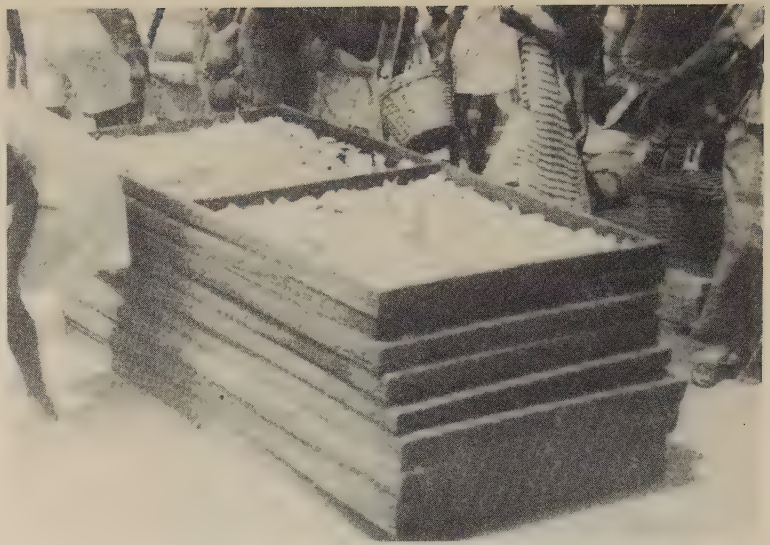

Photo 3

Photo 4

Photo 5

Photo 6

AMELIORATION DU FUMAGE DU POISSON AU NIGER

par

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RESUME

Le fumage est la seule méthode de conservation du poisson pratiquée au Niger. Cette pratique se heurte à des difficultés liées à l'équipement, et à la rareté du bois de fumage. L'expérimentation d'un nouveau modèle de four type "Altona simplifié" a montré que le fumage est plus avantageux avec ce type de four. On estime que le fumage sur l'ensemble du fleuve consomme 12 500 stères de bois soit l'équivalent de 25 000 ha de forêts sahéliennes. L'introduction de nouveaux modèles de fours de fumage auprès des pêcheurs, permettrait de réduire de 40 % la consommation de bois et d'améliorer la qualité du poisson.

1. INTRODUCTION

Le fumage est pratiquement la seule méthode de conservation du poisson en usage dans le pays de manière artisanale au niveau familial. Les équipements actuels de fumage sont constitués par des fours traditionnels de forme ronde ou rectangulaire et de dimensions variables, construits en banco par les pêcheurs eux-mêmes.

La méthode de fumage à chaud consiste à exposer le poisson à 50-60 cm au-dessus d'un feu. La durée moyenne d'une opération de fumage varie entre 2 et 5 jours suivant la taille et la qualité du poisson (gras ou maigre) quelles que soient les espèces capturées.

Cette pratique se heurte cependant à de nombreuses difficultés souvent inhérentes à la conception même de l'équipement de fumage, notamment:

- la consommation relativement élevée en combustible;
- la capacité réduite des fours;
- des pertes de temps;
- des risques fréquents d'incendies;
- la médiocrité de la qualité du produit fumé. La rareté et le coût élevé du bois de chauffe dans certains secteurs du fleuve (Ayorou) constituent un handicap à la pratique d'un fumage correct.

Le Niger, comme tous les pays du Sahel, est menacé par la désertification, et le problème de bois de chauffe se pose avec acuité.

Dans le cadre du Projet de développement des pêches au Niger, la mise au point d'un équipement de fumage adaptable par les pêcheurs aux conditions locales, permettant de réduire la consommation de bois, et d'améliorer la qualité du produit est nécessaire.

Les expérimentations effectuées dans ce cadre avaient pour objet, de déterminer les performances de deux modèles de fours traditionnels par rapport à celui qui est utilisé le plus couramment par les pêcheurs, et d'estimer la consommation de bois de fumage pour l'ensemble du secteur.

2. MATERIEL ET METHODOLOGIE

Les essais se sont déroulés à Niamey et à Ayorou comme suit:

(a) Construction des fours

Les fours construits avec des briques d'argile; les claies avec du grillage déployé;

- Four Haoussa (H): modèle utilisé par les pêcheurs, de forme circulaire construit avec 50 briques de 40 x 20 x 10 cm avec les dimensions intérieures suivantes:

- hauteur totale: 80 cm
- hauteur claie: 50 cm
- diamètre: 90 cm
- ouverture du foyer: 40 x 30 cm

- Four Haoussa + tunnel (HT): même modèle que précédemment auquel il faut adjoindre un tunnel qui recule le foyer à 70 cm du four.

- Four Altona Simplifié (AS): de forme rectangulaire, il comprend un foyer de 90 cm de hauteur, surmonté d'une cellule de fumage de 50 cm de haut. Les dimensions intérieures du four sont:

- hauteur: 140 cm
- longueur: 120 cm
- largeur: 60 cm
- ouverture du foyer: 30 x 30 cm

Il est muni dans la cellule de 2 ouvertures latérales de 10 x 10 cm et d'une ouverture frontale de 40 x 50 cm, de deux claies et d'une toiture hermétique constituée d'une feuille de tôle. L'ouverture frontale est munie d'un volet ajusté.

Il est construit avec 130 briques de 40 x 20 x 10 cm.

(b) Protocole expérimental

Huit expérimentations ont été réalisées dont 2 à Niamey et 6 à Ayorou, sur un poids total de 252 kg de poisson.

Les lots étaient hétérogènes par la taille et la qualité (maigre ou gras). Chaque lot était préparé (écaillé, éviscéré), lavé, égoutté et posé.

Au cours de la 1ère étape à Niamey, chaque four fut chargé suivant sa capacité propre alors que à Ayorou chacun des fours reçut une quantité égale de poisson, ce qui a nécessité une claie supplémentaire pour les fours H et HT.

Le combustible était du bois disponible sur le marché, toutes essences confondues.

Au cours du fumage les deux fours H et HT étaient couvert de nattes. Les observations portèrent sur la quantité de bois consommé (exprimée en kilo bois/kilo poisson préparé), le temps de fumage, la qualité du produit fini et le rendement.

3. RESULTATS ET COMMENTAIRES

Les résultats chiffrés des observations sont consignés dans le tableau en annexe 1 (total des huit répétitions).

(a) Consommation de bois

La consommation de bois par four (voir tableau) est surtout fonction de la charge, la taille du poisson, la qualité (maigre ou gras) et du vent (direction et force).

La consommation exprimée en kilo de bois/kilo de poisson à fumer est plus importante pour les petites quantités et également pour les poissons gras et de grande taille mais plus marquée pour les fours H et HT.

Ces deux fours ont sensiblement les mêmes consommations avec une légère différence en faveur du four T. Il y a une nette différence de consommation en faveur du modèle AS, de l'ordre de 30 à 50 %.

(b) Durée

La durée d'une opération de fumage détermine la consommation de bois. Elle est également liée à la quantité, la qualité (maigre ou gras) et à l'épaisseur du poisson. La durée d'une opération est plus courte dans le modèle AS; les deux autres nécessitent sensiblement le même temps pour une quantité égale.

(c) Rendement final

Il est fonction de la taille et de la qualité du poisson (maigre ou gras) (voir tableau).

(d) Qualité

Le réglage du feu, la maîtrise de la chaleur et de la fumée déterminent la qualité, et dépendent de l'habileté de l'opérateur.

Les changements de la direction du vent perturbent le fonctionnement du HT et rendent difficile le réglage du feu et la maîtrise de la chaleur.

La faible hauteur à laquelle se trouve la claie du "H" nécessite que le feu soit légèrement en retrait du produit, ce qui entraîne une plus grande déperdition de chaleur et de fumée. En outre, quand il vente la qualité du produit est affectée. Grâce aux 3 ouvertures (à fermer), à sa toiture hermétique et au niveau auquel se situent les claies, le modèle AS permet une plus grande maîtrise de la température et de la fumée; par un réglage plus aisé du feu.

Pour avoir un fumage uniforme, il est nécessaire de retourner et de changer l'emplacement du poisson au cours du fumage, dans les fours "H" et "HT" alors qu'on peut souvent se passer de le faire dans le modèle AS, sauf dans le cas des poissons les plus gras.

Selon un groupe de pêcheurs Haoussa, auquel nous avons fait appel pour une appréciation des différents produits fumés à Ayorou, la meilleure qualité de poisson fumé se définit au Niger par une coloration noirâtre (carbonisation superficielle). Il ressort de l'avis de ces pêcheurs que les produits du modèle "AS" ont une qualité nettement supérieure à celle des deux autres fours, celle du "H" étant légèrement supérieure à celle du HT.

4. CONCLUSION

Les résultats chiffrés ainsi obtenus n'ont pas un caractère scientifique absolu. Ils permettent de comparer le fonctionnement de ces 3 modèles de fours. A partir de ces observations, on peut affirmer que le fumage bien conduit avec les 3 modèles de four, dans les mêmes conditions de travail, est meilleur avec le modèle AS: consommation de bois moindre, temps plus court et qualité supérieure. Les deux autres donnent des résultats assez voisins. Par contre l'investissement initial à effectuer est plus du double de celui des deux autres, et la manutention y est relativement moins aisée. Selon nos estimations, le fumage, tel qu'on le pratique au Niger avec le modèle "H" (qualité, durée, quantité), utiliserait en moyenne de 2 à 3 kg de bois par kilo de poisson fumé. L'utilisation par les pêcheurs du modèle AS permettrait de réduire la consommation de bois d'environ 40 % et d'obtenir un produit de meilleure qualité en un temps un peu plus court.

ANNEXE 1

Tableau du résultat des 8 répétitions

	Altona simplifié	Four "Haoussa"	Four "Tunnel"
Poids du poisson avant préparation (kg)	89,15	81,5	81,5
Poids du poisson préparé (kg)	79	73	73
Poids du poisson après fumage (kg)	28,95	25,2	25,2
Quantité de bois consommé (kg)	94	128	118
kg de bois/kg de poisson	1,18	1,75	1,61
Durée moyenne par journée (heures)	15	17	17
Pourcentage de perte de poids au cours du fumage	63,35	65,47	65,47
Rendement final (par rapport au poisson entier)	32,47 %	30,92 %	30,92 %
Qualité du produit	bonne	assez bonne	passable
Investissement FCFA[a]	8 200	3 100	3 250

[a] Il est évident que la différence d'investissement initial est rapidement compensée par la moindre consommation de bois.

On peut considérer qu'une économie de 1 kg de bois/kg de poisson à fumer dans AS permettra de récupérer la différence d'investissement qui est de FCFA 5 100, sur 400 kg de poisson environ (FCFA 12,5/kg de bois) soit environ 20 fournées à raison d'une charge moyenne de 20 kg de poisson.

ANNEXE 2

Estimation de la consommation de bois de fumage sur l'ensemble du fleuve

1. DONNEES

Production totale annuelle du fleuve en poisson: 2 000 tonnes

Production totale annuelle destinée au fumage: (60 %: soit 1 200 tonnes)

Rendement poisson frais-fumé: 30 %

Production de poisson fumé par an: 400 tonnes

Prix moyen de poisson fumé en territoire nigérien: FCFA 800/kg

Valeur annuelle moyenne de la production de poisson fumé: FCFA 320 millions

Consommation en bois du four traditionnel "Haoussa" par kilo de poisson à fumer: 2,5

Production annuelle de 1 ha de forêt sahélienne: 0,5 stère de bois.

Poids d'un stère de bois: 240 kg

Prix d'un stère de bois: FCFA 3 000

2. CONSOMMATION ACTUELLE DE BOIS DE FUMAGE/AN

1 200 tonnes x 2,5 = 3 000 tonnes

Stères consommés $\frac{3\ 000}{0,24}$ = 12 500 stères

ha de forêt consommé: $\frac{12\ 500}{0,5}$ = 25 000 hectares

Valeur du bois consommé
12 500 x 3 000 FCFA 37 500 000

Incidence du prix du bois sur la valeur du poisson fumé: 11,71 %

Dépense moyenne en bois/famille: FCFA 30 000

3. IMPACT DU FOUR "ALTONA SIMPLIFIE"

Consommation de bois	1 200 tonnes
Stères consommés	5 000 stères
Equivalent ha de forêt sahélienne	10 000 hectares

THE DESIGN OF AN IMPROVED TRADITIONAL SMOKE-CURING OVEN

by

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ABSTRACT

A simple smoke-curing oven with three revolving shelves has been constructed from a 200 litre oil drum. The oven is insulated and has a closed top. The smoking chamber is heated by means of steam generated in a càn beneath the oven. Welded to the steam generator are a series of vertical and horizontal copper pipes with sealed ends.

The horizontal copper pipes are at 3 levels along the vertical pipe and constitute the supporting arms as well as the heating mechanism for the shelves. The oven maintains a uniform temperature of 80°C (±5°C) at all the shelf levels.

Smoke is generated from a separate combustion chamber by burning wood shavings. Smoke enters the chambers by way of vertical and horizontal flues. The vertical flue delivers smoke to the top of the oven, and by means of a top horizontal spreader, a downward stream of smoke is delivered into the chamber. The horizontal flue delivers smoke to a spreader at the bottom of the oven which provides an upward stream of smoke. By this arrangement all sides of fish are evenly exposed to smoke. Valves are located in the flues to control the volume of smoke that enters the chamber.

The oven has been successfully used to smoke herrings (Sardinella eba), and the product was organoleptically desirable to a taste panel who compared it with smoked herring processed in traditional ovens. The oven has an improved fuel efficiency and an increased volume capacity.

1. INTRODUCTION

Smoke curing of fish is usually carried out in smoking ovens or kilns. The traditional Ghanaian oven is cylindrical in shape and is constructed with mud or bricks. Metal ovens are constructed with a 200 litre oil drum and the capacity can be increased by joining 1 1/2 or 2 of the drums (Fig. 1C).

Modern mechanical smoking kilns are in the form of rectangular buildings of metal, brick or wood construction. An example of this is the Afos Torry Kiln currently used by the Tema Food Complex Corporation in Ghana.

Traditional ovens are cheap and easy to construct, sometimes without skilled labour. However, these ovens have some drawbacks such as poor distribution of heat and smoke and low volume capacity.

Attempts have been made in Ghana to design improved smoking ovens to be used by traditional fish smokers. These includes the Adjetey Oven (Fig. 1A), the Altona Oven (Fig. 1B) and the Rectangular Oven (Fig. 1D). In spite of the merits of these improved ovens, the new designs have not made any significant impact in Ghana except the rectangular types.

Orraca-Tetteh and Nyanteng (1978), have noted that this may be due to the high initial cost involved in the construction of the new ovens and their elaborate methods of operation.

This paper describes the fabrication of a simple fish smoking oven with an increased volume capacity and devices for controlling heat and smoke distribution in the oven.

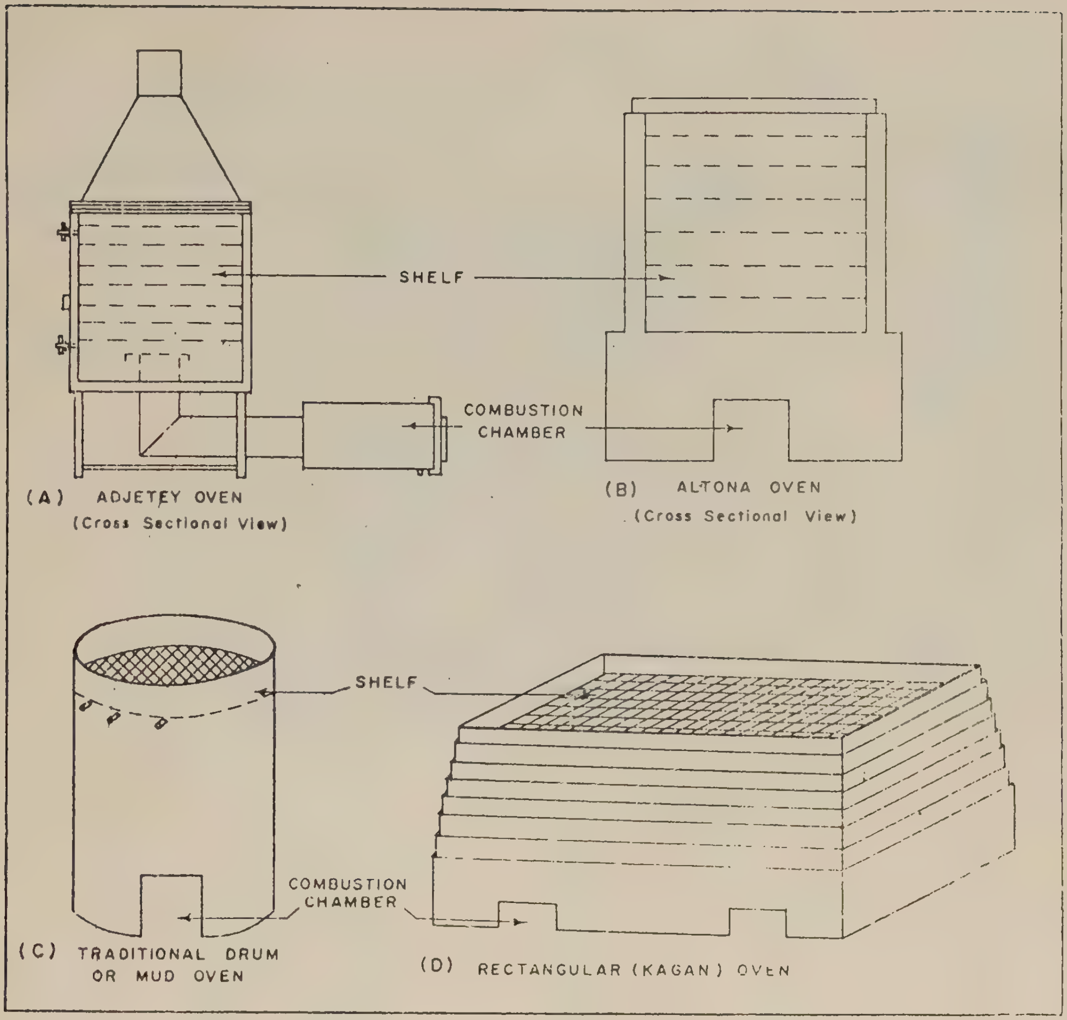
SHELF
COMBUSTION CHAMBER
(A) ADJETEY OVEN
(Cross Sectional View)
(B) ALTONA OVEN
(Cross Sectional View)
SHELF
COMBUSTION CHAMBER
(C) TRADITIONAL DRUM OR MUD OVEN
(D) RECTANGULAR (KAGAN) OVEN

Figure 1 Fish smoking ovens in Ghana

2. MATERIALS AND METHODS

2.1 Materials and Cost of Construction of Oven

Materials and Labour	Cost (Cedis)[1/]
Galvanized pipe (5 cm diameter)	20
P.V.C pipe (5 cm diameter)	12
P.V.C. pipe (4 cm diameter)	38
Copper pipe (2 cm diameter)	60
Copper pipe (0.64 diameter)	20
Wire mesh	10
Oil drum (200 litre)	80
Ball bearing	10
Electric stove	50
Wooden boards	60
Galvanized sheet	20
Cylindrical can	35
Paper board	-
Labour - Oven construction	150
- Wooden trolley construction	40
TOTAL	605

1/ 1982 prices, $1.00 = ¢2.75

2.2 Construction of the Oven and its Operation

The oven (Fig. 2 Plates 1-3), consists of 3 parts:

(a) Smoke Generator

This consists of a cylindrical galvanized can (2) with vertical (6) and horizontal (4) flues connected to the top and bottom of the oven, respectively. The smoke generator rests on a stand (1). The top of the can is covered with a lid when in operation.

(b) Smoking Chamber

The smoking chamber (7) was constructed from a 200-litre oil drum with a hinged front door. The sides were insulated with card-board. The oven rested on a wooden trolley (17).

(c) Heating Element

This is made of a vertical copper pipe (8) interconnected to horizontal side arms (9) - also made up of copper pipes at three different levels. The system of copper pipes is welded to a 4-litre can (18) placed on an electric stove (19) for steam generation.

The side arms were over-laid with wire mesh and this constituted the shelves for the fish. The entire assembly revolves on a ball bearing (16).

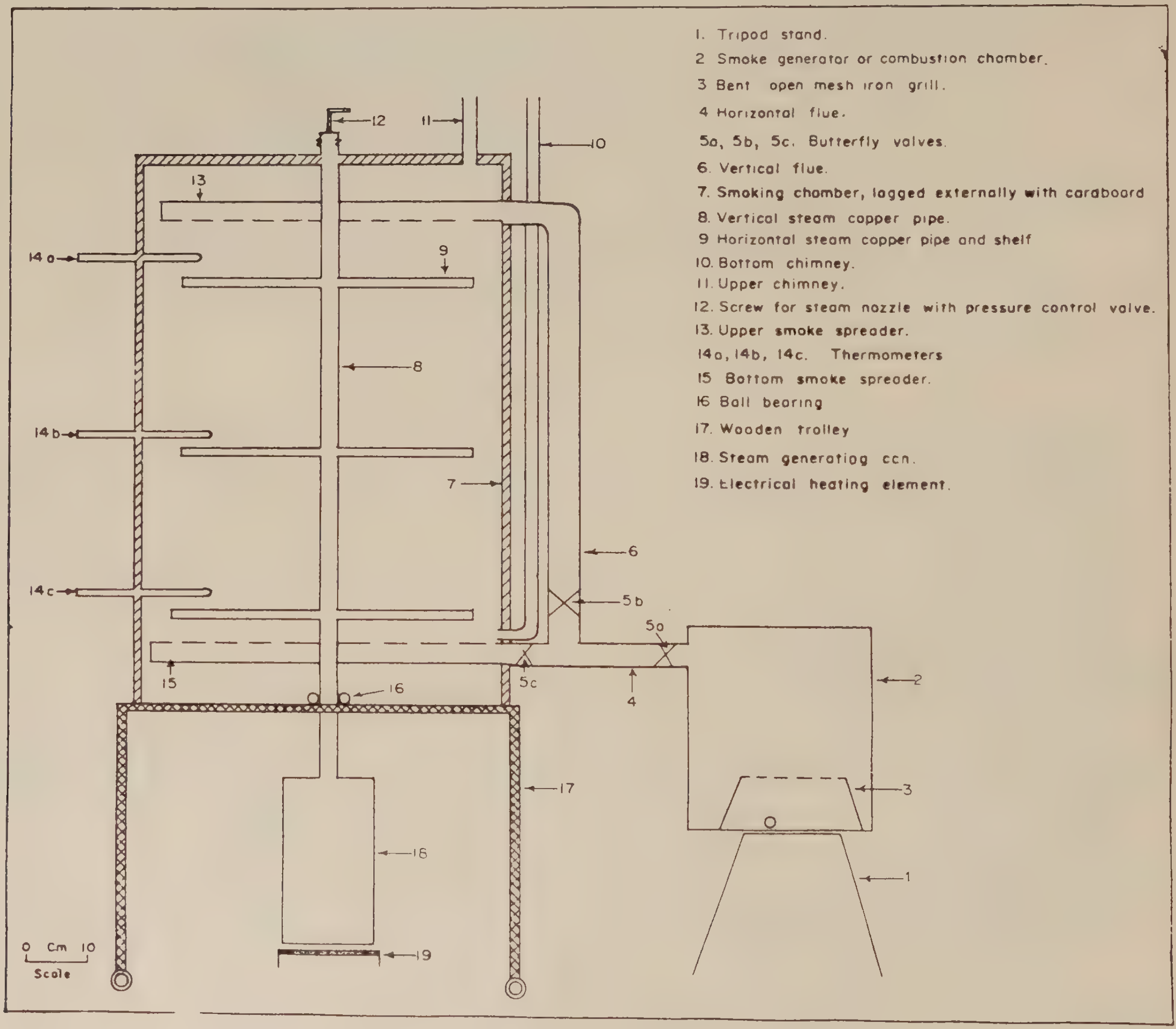
1. Tripod stand.
2. Smoke generator or combustion chamber.
3. Bent open mesh iron grill.
4. Horizontal flue.
5a, 5b, 5c. Butterfly valves.
6. Vertical flue.
7. Smoking chamber, lagged externally with cardboard
8. Vertical steam copper pipe.
9. Horizontal steam copper pipe and shelf
10. Bottom chimney.
11. Upper chimney.
12. Screw for steam nozzle with pressure control valve.
13. Upper smoke spreader.
14a, 14b, 14c. Thermometers
15. Bottom smoke spreader.
16. Ball bearing
17. Wooden trolley
18. Steam generating can.
19. Electrical heating element.
12
11
10
13
9
14a
14b
14c
8
7
6
5b
5a
5c
4
15
16
2
3
17
1
18
19
0 Cm 10
Scale

Figure 2 Cross sectional view of the oven

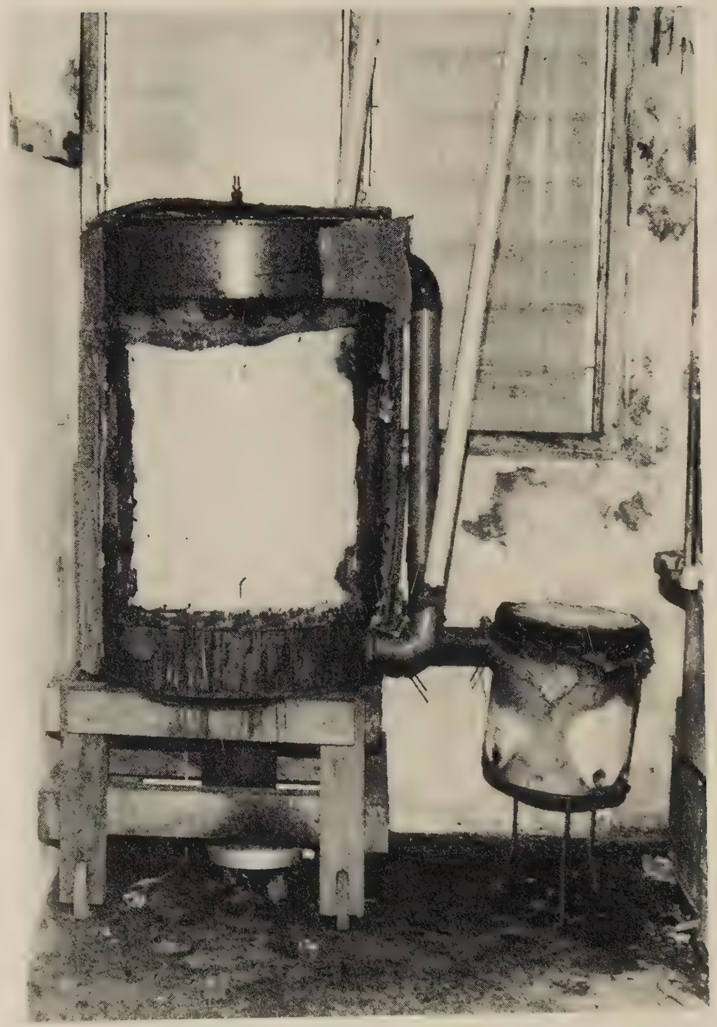

Plate 1 Fabricated fish smoking oven, showing lagged walls, hinged door (white region), smoke generator and chimneys

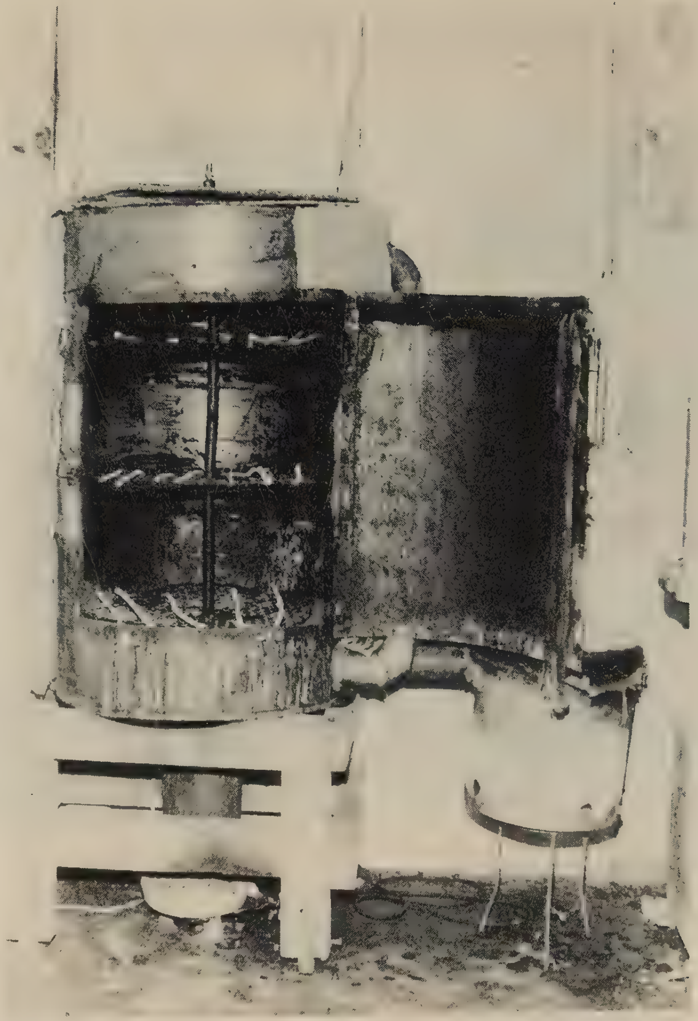

Plate 2 Door of oven open to expose steam pipes and shelves

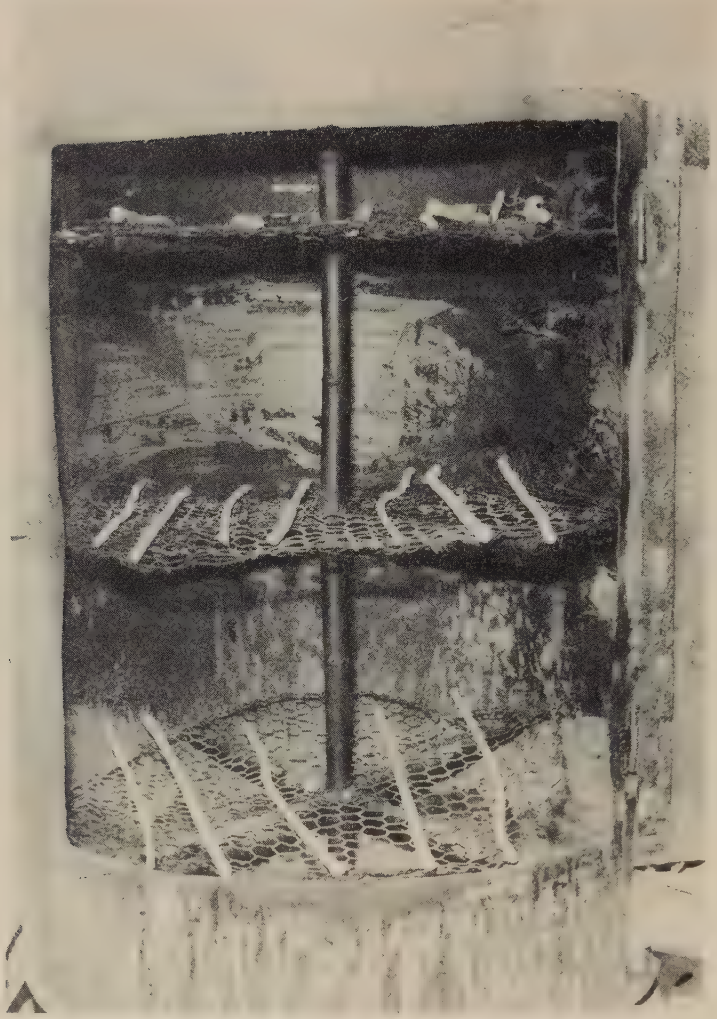

Plate 3 Inside view of oven showing details of the steam pipes and shelves

To operate the oven, the steam generating can (18) is filled with 4 litres of water and heated to boiling. Air is allowed to escape from the copper pipes through a nozzle (12) for 10-15 minutes after which the nozzle is screwed in to trap the steam in the copper pipes.

Smoke was produced by burning wood shavings in the smoke generator. Continuous burning was effected by creating an air space in the can with a bent metal grill (3) and 3 holes at the lower end of the smoke generator.

Smoke entered the smoking chamber through a vertical and a horizontal flue. Two chimneys were provided on the bottom (10) and top (11) of the smoking chamber. The volume of smoke entering or leaving the chamber was regulated by using a system of butterfly valves (5 abc) in the flues.

Temperature inside the oven was determined with a glass thermometer (14 abc), and relative humidity was estimated from a chart after determining the wet and dry bulb temperatures inside the oven.

2.3 Intensity and Distribution of Smoke Inside the Oven

The intensity and distribution of smoke inside the oven was studied by determining the colour developed and the amount of phenols deposited on filter papers placed on each of the 3 shelves.

Colour was determined by the method of Linton and French (1945), and phenols were analysed by the method of Hanley et al. (1955)

For comparative studies, the temperature changes in a traditional cylindrical metal oven during smoking was studied at the James Town beach in Accra.

3. RESULTS

The temperatures at three different levels inside the oven are shown in Table 1.

Figure 3 also shows the temperature changes inside and outside the insulated and unlagged oven.

Table 2 and Figure 4 show the temperature and relative humidity changes inside the oven when 40 pieces of herrings (Sardinella eba) were hot smoked, compared with temperature changes in a traditional oven.

The distribution of phenols in the oven when in operation is shown in Fig. 5.

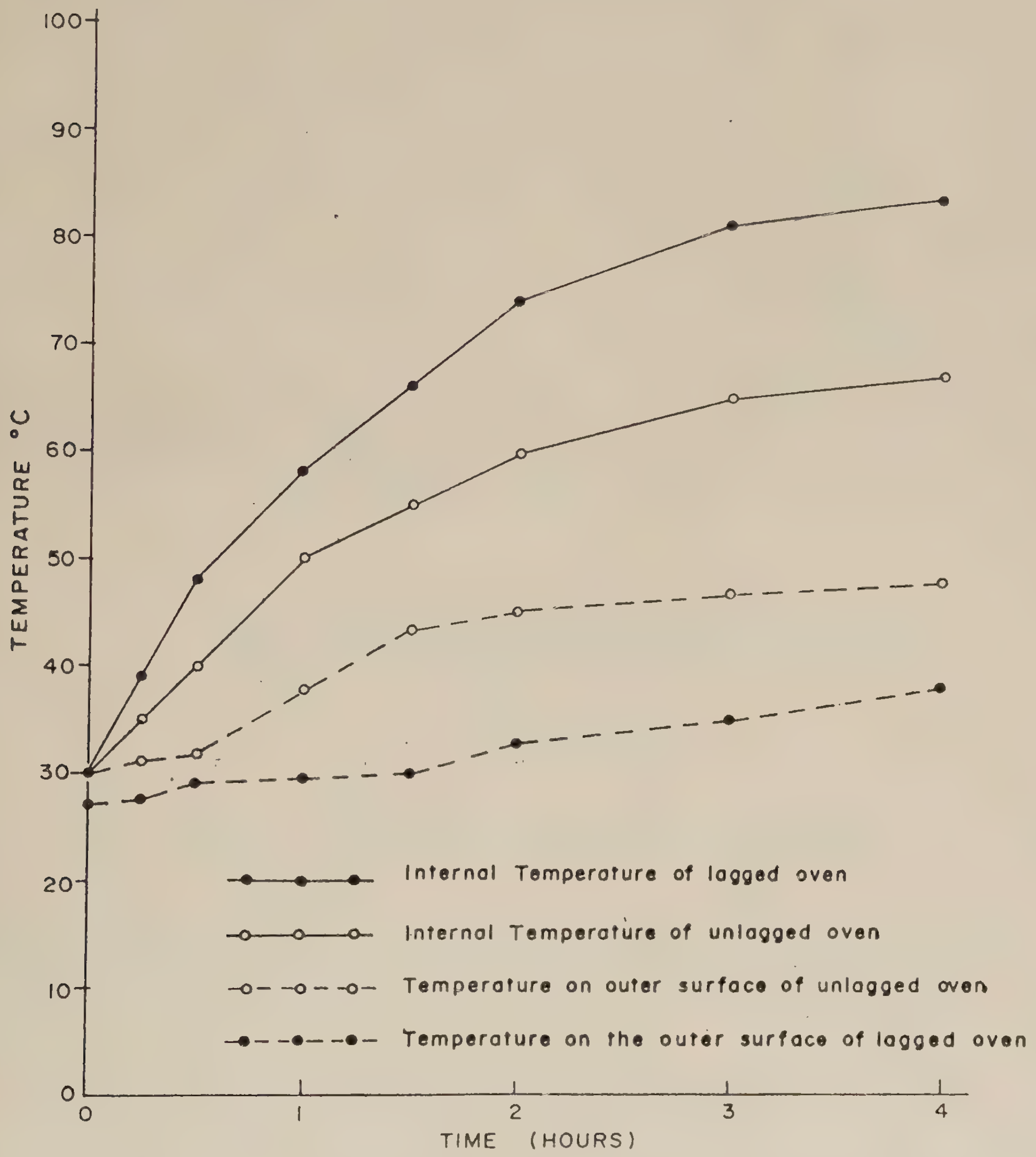

Figure 3 Temperature changes inside the empty oven during heating

Table 1

Temperature on each of the 3 shelves during heating of the empty; lagged oven without smoke (all chimneys closed)

	Heating Time (minutes)							
	30	45	60	90	120	150	180	210
	Temperature (°C)							
Top	50.0	55.0	57.0	64.0	68.0	70.0	75.0	81.0
Middle	48.0	52.0	55.5	61.3	65.0	67.5	73.0	78.0
Bottom	46.0	50.5	54.5	59.3	63.5	66.5	70.0	75.5
Mean	48.0	52.5	55.5	61.3	65.5	68.0	72.5	78.2
Standard deviation	±3.46	±3.97	±2.52	±4.36	±3.98	±3.50	±3.19	±3.89

4. DISCUSSIONS AND CONCLUSIONS

The values in Table 1, and Figures 3 and 4 indicate that the new oven maintained uniform heat distribution during operation. This is shown by the relatively low difference in temperature (5°C) between the shelves. This is of great interest because in the traditional oven, and also in some new designs such as the Altona, uniform heat distribution is not attained within the entire smoking chamber and the fish or shelves are re-arranged to achieve desirable results.

Table 2

Temperature and humidity changes inside lagged oven and fish muscle during smoking. (Oven pre-heated to 67°C before loading with fish)

	Smoking Time (hours)												
Type of oven and location in fish	0.0	0.25	0.50	0.75	1.00	1.50	1.75	2.00	3.00	4.00	5.00	6.00	7.00
	Temperature (°C)												
New oven	67.0	67.5	69.0	71.5	73.0	75.5	77.0	79.0	79.5	80.0	80.5	81.5	-
Traditional oven	30.0	-	55.0	-	76.0	-	-	95.0	100.0	105.0	98.5	72.0	72.0
Fish muscle (herrings in new oven)	28.5	28.5	36.0	43.0	48.0	52.5	57.5	60.0	64.0	65.5	67.5	69.0	-
	% Relative humidity												
New oven	25.0	30.0	40.0	50.0	53.0	53.0	45.0	40.0	30.0	25.0	25.0	25.0	-

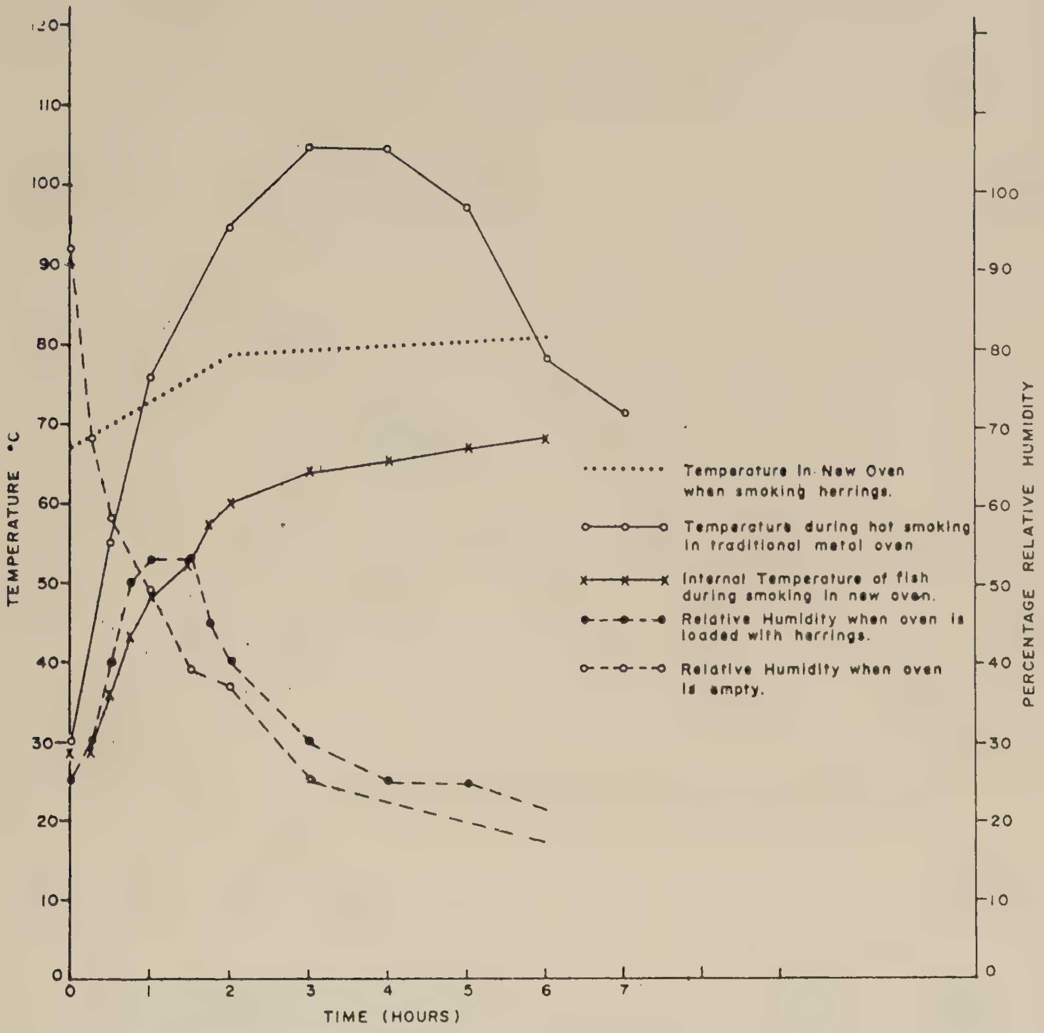

Figure 4 Temperature and humidity changes inside the oven during smoking and drying of herrings

The design of traditional ovens with an open top, leads to considerable heat loss. In the drum type of ovens, heat may also be lost through the bare surface. The closed top and the insulation introduced in this design resulted in a marked improvement in heat retention inside the oven (Fig. 3).

During smoke-curing of fish in the new design, there was a steady increase in temperature from 67°C to 81°C. This contrasts with temperature changes in the traditional oven which showed fluctuations. The high temperature recorded in the traditional ovens often caused charring of the underside. The high temperature may also affect the nutritional quality of the fish. (Wolfe, 1975; Rawson and Sai, 1966). The uniform temperature of 81°C that was maintained in the new design agrees with the recommended temperature range of 80°C-90°C required for hot smoking (FAO, 1970). Under such conditions the fish are smoked and cooked. Temperatures above 80°C are sufficient to kill most surface bacteria such as Clostridium botulinum (Ayres *et al.*, 1980).

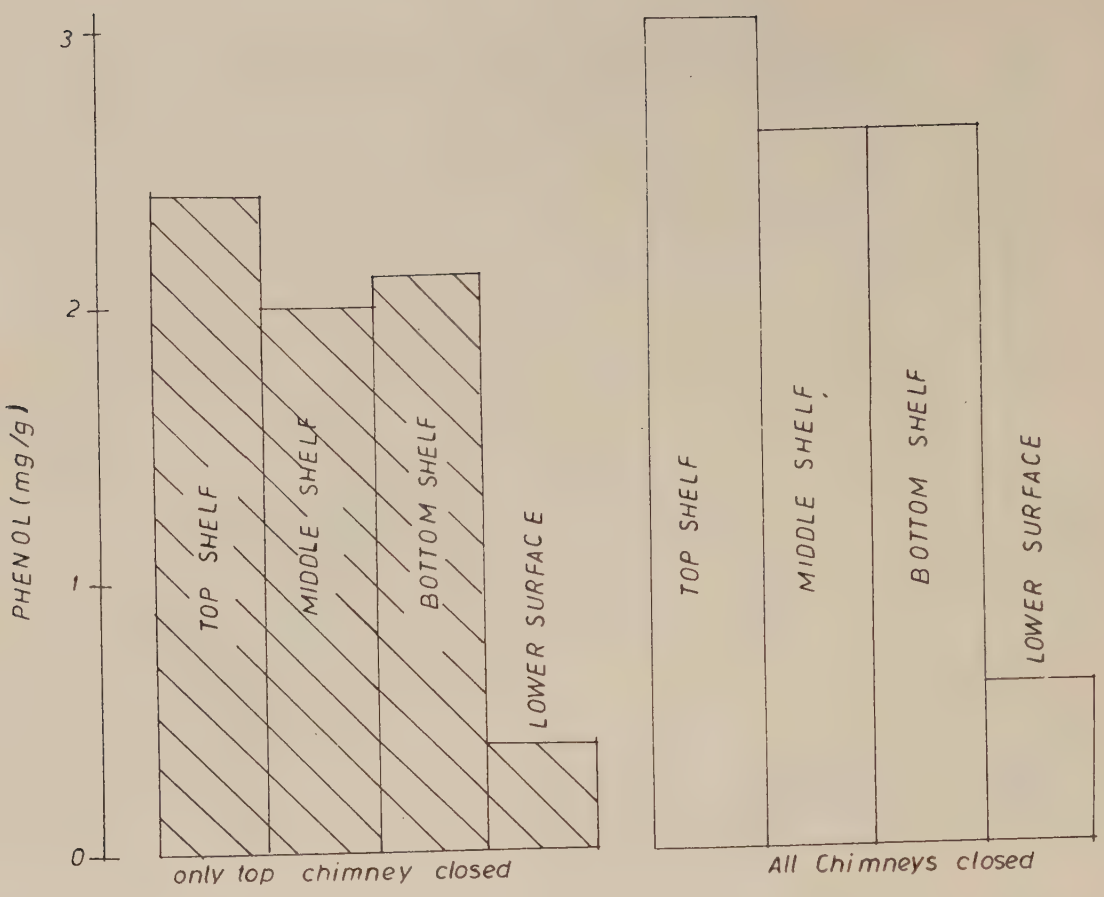

Figure 5 Effect of position of filter paper in the oven on deposition of phenols

Figure 4 shows that the relative humidity inside the oven fell below 25% after 4 hours of operation. This low relative humidity would enhance drying which is important in smoke-curing because it reduces the moisture content and therefore the water activity. Low water activity is related to reduced microbial growth.

Smoke distribution inside traditional ovens is uneven, and considerable amounts of smoke are lost during curing. The results of this work (Fig. 5) show a uniform smoke distribution inside the oven. This is indicated by the uniform colour intensity and concentration of phenols on the surface of dry filter papers. It was observed that the upper surface of the filter papers were intensely yellow compared to the undersides. This closely agrees with the observation by Linton and French (1945) and Shewan (1945) that smoke components involved in colour development settle on the upper surface by gravity.

Preliminary organoleptic tests have shown that the external colour, taste, aroma and texture of the smoked herring cured in this oven were acceptable to a taste panel, when compared with market samples of the same type of smoked fish.

4.1 Fuel and Energy Consumption of the Oven

In operation, it was observed that 2.4 kg of wood shavings (20% moisture content) could generate smoke for 2 hours. Assuming a gross calorific value of wood of 140 MJ per kilogram (Leach, 1976), 2.4 kg of wood will provide 30.6 MJ of heat. The stove had a capacity of 1 500 watts. Thus when operated for 9 hours it provided 48.6 MJ. The total energy input is therefore 79.2 MJ which is equivalent to burning 5.65 kg of wood. Thus 1 kg of herrings required 0.75 kg of wood to complete smoking.

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EXTENDING THE SHELF-LIFE OF SMOKED MACKEREL

by

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ABSTRACT

An experiment was conducted to determine the effects of chemical treatment, during the curing stage, on the shelf-life and acceptability of hot smoked mackerel. Brine solution consisting of citric acid, potassium sorbate, sodium chloride, with or without butylated hydroxy toluene (BHT) were used for treatment. Samples dipped in 15% brine served as control. Frozen fish were allowed to thaw at room temperature (25°-30°C), split, cleaned and washed. Samples were dipped for 5 min in different solutions, drained, smoked for 6 h and cooled at room temperature. Products were packed individually in polythene bags, stored at 25°-30°C and used for chemical, sensory evaluation and microbiological analysis.

Samples dipped in 15% brine (control) were considered unacceptable by the fifth day of storage. These samples were covered by visibly mouldy mass of mycelium. Samples dipped in citric acid - potassium sorbate - sodium chloride solution (no BHT) were unacceptable after 4 weeks storage. Samples treated with citric acid - potassium sorbate - sodium chloride - BHT solution were acceptable after 8 weeks of storage.

1. INTRODUCTION

Fish is mainly thought of as a source of protein. Fish protein compares favourably with eggs, milk and meat in its amino acid composition and in fact, often has higher levels of essential lysine and methionine both of which are lacking in a tuber-based or cereal-based diet (Borgstrom, 1962). This makes fish protein particularly valuable in many countries where the staple diet consists of starchy foods like cassava, yam, rice, sorghum and millet. The lack of livestock and fresh meat product in many parts of Nigeria makes fish protein all the more essential.

Fish preservation is a crucial aspect of fisheries commerce in Nigeria, especially because the high, usually prevailing temperature causes rapid deterioration of the fish. Only a negligible proportion of the fish caught in the rivers and lakes of Nigeria is marked fresh. By far, the greater portion is preserved by smoking or sun drying (Osuji, 1977). There are lots of problems (handling, processing, storage, etc.) associated with the traditional methods of fish smoking in Nigeria. Insufficiently dried fish are prone to fungal infection. Considerable quantities are also lost through insect infestation, bacterial decomposition and fragmentation. Using the limits set by Maembe (1962), it is possible to classify processed fish into high moisture (over 20% water), medium moisture (10-20% water) and dry (less than 10% water). Smoked fish with a moisture content above 20% have a shelf-life of less than five days during storage at room temperature (25°-30°C). Other than drying, fish processors in Nigeria have not achieved a reasonable degree of success with regards to preservation. Dried products are unacceptable to some consumers. The objective of this study is to determine the effectiveness of chemical treatment, during the curing stage, in arresting fungal infection, bacterial decomposition and oxidative rancidity of high moisture (over 20% water) and medium moisture (10-20%) smoked English mackerel (Scomber scombrus).

2. MATERIAL AND METHOD

2.1 Collection of Materials

The mackerel (Scomber scombrus) used for this study was obtained from a local cold store in Nsukka and was processed immediately.

2.2 Preparation of Fish for Smoking

Frozen fish was allowed to thaw at room temperature (29°C). Splitting was carried out as described by Rogers, Cole and Smith (1975).

2.3 Preparation of the Smoking Kiln

The smoke house used was designed by Talabi and Igbinosum (1977) at the Nigerian Institute for Oceanography and Marine Research, Lagos. Essentially, the equipment is a smoke-house with a heating system like a chimney type of chamber.

2.4 Preservatives

The percent concentration of chemicals included in different solutions serving as preservatives is shown in Table 1. In this study, potassium sorbate served as mould and yeast inhibitor, citric acid was used as a chelating agent, acidulant and flavour modifier. The BHT which acted as an antioxidant, was dissolved in 95% ethanol.

The prepared samples were dipped into the various solutions for five minutes, laid on tray with split surface upward and allowed to drain at room temperature.

Table 1

Percent concentration of chemicals in solution

Components	Solutions				
	1	2	3	4	5
Potassium sorbate	6.00	6.00	6.00	-	4.00
Citric acid	7.00	7.00	7.00	-	7.00
Sodium chloride	15.00	15.00	15.00	15.00	15.00
Water	71.90	71.60	72.00	72.00	73.60
BHT	0.02	0.08	-	-	0.08
Ethylalcohol	0.08	0.32	-	-	0.32

2.5 Smoking of Fish

Samples were introduced into the smoke house (preheated for 30 min) and smoked for 6 h. A temperature of about 85°C was achieved after 4 h of firing and this was maintained. The sides were removed after 6 h of smoking, allowed to cool at room temperature and packed in polythene bags. The packaged fish were packed in cartons and stored at room temperature (25^{o}-30^{o}C) for 8 weeks.

2.6 Chemical Analysis

Protein, lipid and moisture content of smoked products were determined according to the Association of Official Analytical Chemists (AOAC, 1975) procedures. Peroxide value was determined according to the method reported by Lee (1971).

Sodium chloride content was determined using the Volhard method as reported by Pearson (1976).

2.7 Panel Evaluation of Product Quality

Subjective evaluations of product quality were carried out by an experienced panel composed of 10 students and staff from the Department of Food Science and Technology, University of Nigeria, Nsukka. Quality attributes studied include appearance, juiciness, saltiness, rancidity, flavour and general acceptability. For evaluation, products were rinsed with water for one minute, covered with aluminium foil, heated in an oven at 250°F for 30 min and allowed to cool at room temperature before presentation to the panel.

Panel members scored all factors on a 5-point Hedonic Scale (Table 2). Refrigerated untreated smoked fish was used as a control (treatment 4).

2.8 Microbiological Analysis

Mould and yeast count was done using Sabouraud Dextrose Agar (SDA). As bacterial inhibitor 0.05% chloramphenicol was used. Appropriate dilution of samples were plated according to standard procedures (Speck, 1976).

Table 2

Sample score sheet used by taste panel

Sample No ....

Scorer ....

Date ....

Factor	1	2	3	4	5
Appearance	Unacceptable	Fair	Medium	Good	Very good
Juiciness	Dry	Fair	Medium	Juicy	Very juicy
Saltiness	Too salty	Slightly too salty	Acceptable	Slightly salty	No salt
Rancidity	Extremely rancid	Highly rancid	Medium rancid	Slightly detectable rancidity	No detectable rancidity
Flavour	Undesirable	Slightly undesirable	Medium	Good	Excellent
General acceptability	Very bad	Bad	Medium	Good	Excellent

3. RESULTS

3.1 Chemical Analysis

Table 3 summarizes the effect of the different treatments on proximate composition, peroxide value and sodium chloride content of smoked mackerel at the end of an 8 week storage period. The moisture content and salt content of the smoked products varied between treatments ($P < .05$). Samples dipped in solution 1 had significantly lower moisture content when compared to samples dipped in solutions 2, 3, and 5. Samples dipped in solution 1 had significantly ($P < .05$) higher salt content when compared to samples dipped in solution 3 but did not differ significantly from samples dipped in solutions 2, 4, and 5.

Peroxide values obtained for samples dipped in solution 3 were significantly ($P < .05$) higher than the others. Protein and fat content of smoked products did not vary between treatments at the end of an 8-week storage period.

3.2 Sensory Panel Evaluation

Analysis of variance showed that treatments did not affect the saltiness of smoked products during the 8-week storage period. Treatment significantly ($P < .05$) influenced appearance, juiciness, rancidity, flavour and general acceptability (Table 4). Samples dipped in solution 3 were least desired, as regards rancidity and flavour. Figure 1 shows the changes in rancidity of smoked mackerel stored at room (25^{o}-$30^{o}C$) and at refrigeration ($4^{o}C$) temperatures. There was no statistically significant difference ($P > .05$) between values obtained on weeks 0, 2, and 4. Values obtained on weeks 6 and 8 differed significantly ($P < .05$) from values obtained on weeks 0, 1, 2, and 4. Samples dipped in solution 3 were considered unacceptable after the fourth week of storage as reflected in general acceptability scores (Fig. 2). Scores at this period were less than 3, the acceptable limit.

3.3 Microbiological Analysis

Samples dipped in 15% brine (control) were covered by visibly mouldy mass of mycelium by the fifth day of storage and were considered unacceptable. Initial total plate counts for frozen fish samples were above 1×10^6 org/g. Total plate counts obtained after the smoking operation averaged 1×10^1 org/g. Microbial evaluation after 1 month of storage indicated that total plate count on treated samples irrespective of dipping solutions averaged 1×10^3 org/g.

Initial values for yeast and mould counts for frozen fish samples averaged 4.0×10^5 org/g. Yeast and mould counts obtained after the smoking operation for all products were 1×10^2 org/g. Yeast and mould counts of treated samples after one month of storage averaged 1×10^1 org/g.

Table 3

Proximate composition, peroxide value and sodium chloride content of smoked mackerel

Treatment$^{a/}$ Solution$^{b/}$	Moisture	Crude protein	Fat	Peroxide value	Percent sodium chloride
			Proximate composition percent		
1	12.06 ± 0.9$^{a/}$ 11.00 - 16.00*	36.18 ± 1.18$^{a/}$ 33.27 - 40.00*	43.50 ± 1.50$^{a/}$ 40.00 - 47.50*	14.31 ± 2.$^{a/}$ 7.15 - 20.20*	4.64 ± 0.40$^{b/}$ 4.00 - 6.20*
2	18.73 ± 2.28$^{b/}$ 12.00 - 24.00*	36.70 ± 3.60$^{a/}$ 30.20 - 49.90*	41.00 ± 4.58$^{a/}$ 25.00 - 50.00*	10.7$^{a/}$± 1.90$^{a/}$ 6.50 - 17.55*	4.34 ± 0.39$^{ab/}$ 3.59 - 5.70*
3	19.65 ± 1.73$^{b/}$ 17.00 - 26.20*	35.22 ± 1.23$^{a/}$ 32.50 - 38.20*	41.00 ± 1.87$^{a/}$ 35.00 - 45.00*	41.62 ± 6.97$^{b/}$ 22.50 - 58.00*	3.86 ± 0.59$^{a/}$ 1.60 - 6.00*
4	15.54 ± 1.80$^{ab/}$ 11.00 - 24.00*	36.00 ± 2.79$^{a/}$ 35.00 - 39.10*	42.00 ± 2.55$^{a/}$ 35.00 - 50.00*	16.02 ± 1.11$^{a/}$ 13.20 - 19.50*	3.99 ± 0.31$^{ab/}$ 3.39 - 5.20*
5	16.54 ± 1.56$^{b/}$ 12.00 - 20.00*	33.97 ± 1.88$^{a/}$ 30.00 - 40.00*	43.60 ± 1.57$^{a/}$ 40.00 - 48.00*	10.94 ± 1.09$^{a/}$ 7.55 - 14.20*	4.03 ± 0.41$^{ab/}$ 3.00 - 5.50*

* Range

a/ Values are mean ± standard error for ten observations
b/ Formulae of solutions are shown in Table 2

Table 4

Treatment means and standard error (SE) taste panel ratings of smoked mackerel

Treatment Solution$^{d/}$	Appearance	Juiciness	Saltiness	Rancidity	Flavour	General acceptability
1	3.62 ± 0.62$^{b/}$	3.26 ± 0.41$^{ab/}$	3.12 ± 0.23$^{a/}$	4.60 ± 0.28$^{c/}$	3.78 ± 0.40$^{c/}$	4.02 ± 0.34$^{c/}$
2	3.56 ± 0.75$^{b/}$	3.58 ± 0.59$^{b/}$	3.30 ± 0.35$^{a/}$	4.38 ± 0.31$^{c/}$	3.46 ± 0.70$^{bc/}$	3.64 ± 0.29$^{b/}$
3	3.18 ± 0.99$^{a/}$	3.40 ± 0.68$^{ab/}$	3.22 ± 0.59$^{a/}$	3.68 ± 1.38$^{a/}$	3.02 ± 0.85$^{a/}$	3.18 ± 1.06$^{a/}$
4	3.14 + 0.71$^{a/}$	2.94 ± 1.05$^{a/}$	3.18 ± 0.52$^{a/}$	4.56 ± 0.48$^{c/}$	3.60 ± 0.56$^{ab/}$	3.72 ± 0.68$^{b/}$
5	3.04 ± 0.59$^{a/}$	3.00 ± 0.36$^{a/}$	3.30 ± 0.49$^{a/}$	4.06 ± 0.63$^{b/}$	3.36 ± 0.39$^{b/}$	3.36 ± 0.26$^{a/}$

a/, b/, c/ Column values with same superscript are not significantly different ($P > .05$)
d/ Formulae of solutions are shown in Table 2

4. DISCUSSION

There seemed not to be much difference between the protein content of the different treatments (Table 3). Numerically, samples subjected to treatment 5 had lower protein content values.

It would appear that the salt content of smoked products was inversely related to the moisture. Acceptability of product was closely related to the flavour and degree of rancidity. Samples dipped in solution 3 were least desired. This may have been caused by a higher rate of lipid oxidation, leading to increase in rancidity, which consequently, affected the flavour and general acceptability. The increase in rancidity was a result of absence of BHT in solution 3. Lipid oxidation did not pose a problem to refrigerated (control) samples.

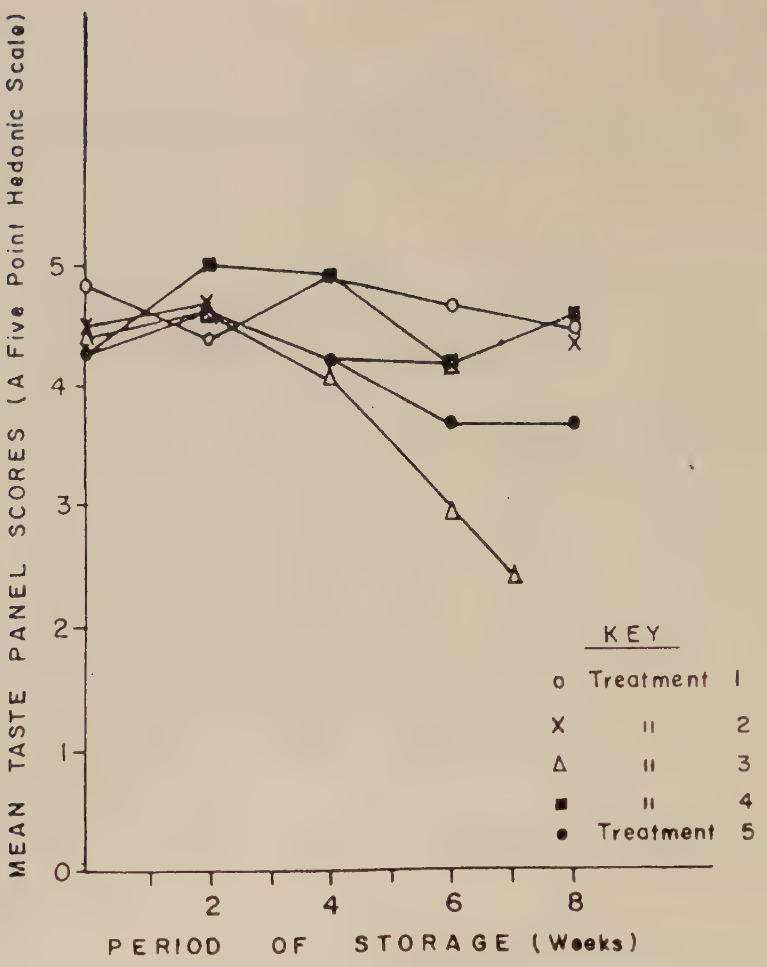

Figure 1 Changes in rancidity of smoked mackerel stored under ambient (room) conditions

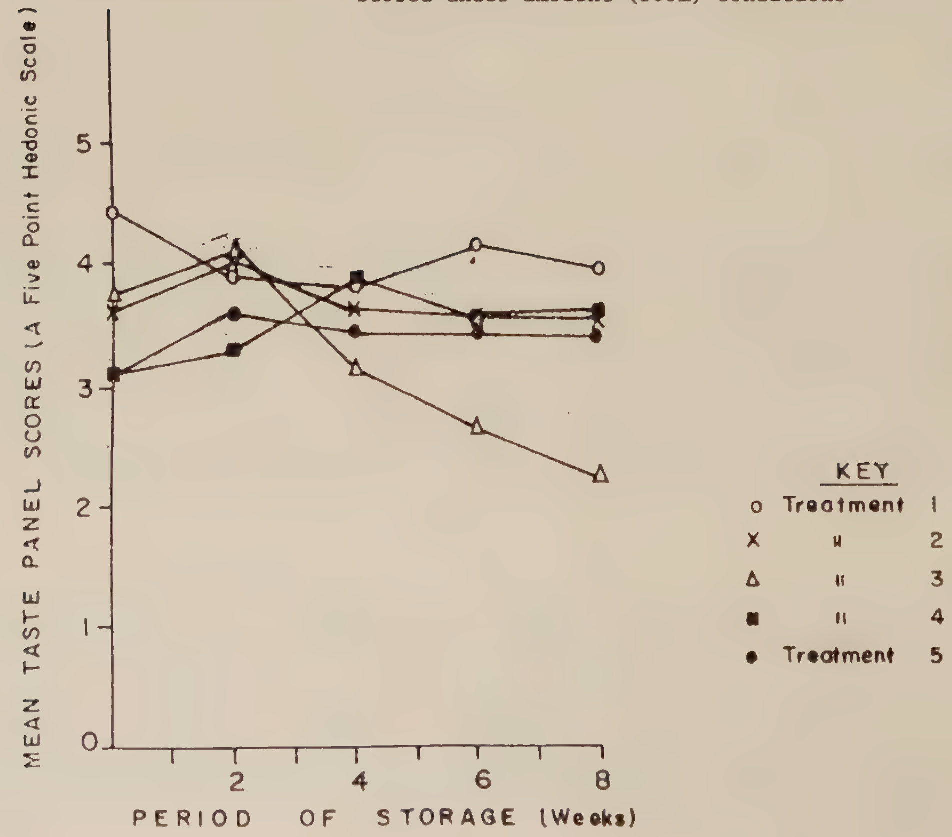

Figure 2 General acceptance of smoked mackerel at various storage period under ambient (room) conditions

The reduction of microbial load after smoking showed that the smoking process was effective in reducing microbial counts. The observation of visibly mouldy mass of mycelium on all control samples by the fifth day of storage under ambient conditions indicated the effectiveness of potassium sorbate as an antimycotic agent hence the superiority of solutions containing potassium sorbate over the control. The use of potassium sorbate - citric acid - sodium chloride - BHT solutions described in this study could extend the shelf-life of smoked mackerel.

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SHELFLIFE STUDIES AND PACKAGING OF SMOKE-CURED SARDINELLA

by

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ABSTRACT

Storage and packaging studies have been carried out on brined, smoke-cured sardinella harvested in two fishing areas along the Cameroonian coast via Limbe and Batoke. The product keeps at ambient temperatures for up to eight weeks in misty and clear polythene at 60° salinometer degree.

Similar studies are being carried out on other common species viz. Ethmalosa spp., Carangidae spp., Pseudotholithus spp., Scombridae spp. and Ilisha africana.

1. INTRODUCTION

It became very necessary to look at possibilities for improving the shelflife of fish in Cameroon because of the relative ease with which smoke-cured fish developed off-flavour and mould infection, more especially in the humid south.

Our choice of Sardinella spp., locally known as "strong kanda", for our shelflife and packaging studies is due to a number of reasons. It is not only the most abundant species throughout the year in Cameroon coastal waters, but it is the cheapest among the common species. Sardinella is under consideration as a raw material to provide a fishmeal for the livestock industry with a higher protein content of 71.75% than the 66.367%, 68.912%, 60.490%, 69.059% and 72.90% obtained with Pseudotholithus spp., Carangidae spp., Ethmalosa spp., Scombridae spp., Ilisha africana, respectively. Its relatively small size (15 cm to 29 cm total length) and low lipid content make it convenient for most feedmills and heat-and-transfer processes.

2. MATERIALS AND METHODS

Sardinella harvested in the Limbe and Batoke areas were bought immediately on landing on 11 September 1984. From the consignments samples were carefully washed in clear tap water, brined for 15 min at 29°C in brine of 0°, 20°, 40° and 60° salinometer degrees, and immediately transferred to the smoking unit.

After 12 h of smoke-curing, the fish were cooled and packaged in the following materials:

- misty polythene
- clear polythene
- aluminium foil
- brown paper
- jute bags

Some fish were not packaged.

The packaged and not packaged samples were transferred to the laboratory where they were kept under observation. The temperature was monitored throughout storage at 6 a.m., 12 noon, 6 p.m. and 12 midnight everyday.

In addition, detailed studies of the following were carried out once every fortnight:

- number of defective fish
- number attacked by rodents, beetles, etc.
- percent of fish with mould
- colour of mould
- number of fish infested with pests and type
- rancidity
- putrefaction with typical ammoniacal smell

All this information was recorded. Samples for proximate analysis were sent to our sister station in Mankon for analysis.

- Moisture content was determined by an oven method
- Ash content was determined by the use of the muffle furnace at 550°C for 24 h
- Protein was determined by auto-analyser
- Lipid was determined by extracting with ether in a Soxhlet apparatus

3. DISCUSSION OF RESULTS

Within the first two weeks of storage most of the unpacked samples were in a very good state; a few were defective. Amongst the packaged ones, samples with brine strength of 40° and 60° were in extremely good condition.

At the end of the fourth week of storage, the following points were very clear:

- for the unpackaged product most of the samples had suffered about 25% mould infection and, in addition, a few of them had been slightly attacked by rodents, with some fouling;

- samples packed in the two types of polythene bags after brining at 60° salinometer reading were in good condition, whereas the rest were slightly attacked by mould, mostly around the gut and head regions;

- all samples packed in aluminium foil were covered with mould, which could be attributed to the low moisture barrier properties of this packing material;

- those in brown paper were still in a good state.

Up to this time no rancidity or putrefaction was observed in any of the materials.

At the close of the sixth week, samples packaged in clear and misty polythene, jute bags and brown paper were still in an edible state, whereas those unpackaged and the remainder in other materials were heavily infested by mould with a slight degree of rancidity and putrefaction. Pest infestation was also present, especially infestation of young beetles in the samples packed in aluminium foil.

Results of proximate analysis were:

- moisture content	5.41%
- ash	21.75%
- protein	71.75%
- ether extract	8.21%

The low lipid content of the fish would facilitate its drying.

Temperature during the studies was 26°-29°C.

4. CONCLUSION

After a storage time of eight weeks, it became evident that salting and packaging individually is very important in the production of smoke-cured sardinella if it is to reach distant consumers in good condition. Brining at brine strength at 60° salinometer degrees and packing in misty or clear polythene bags is ideal for storage beyond two weeks, and brining at 40° salinometer reading is ideal for storage of less than two weeks. It should be noted that a product brined at 60° salinometer is too salty for normal palates, in which case it is better to desalt before use by immersion in warm water.

Whilst this study provides a good introduction, further work has to be done to estimate the effect of seasonal fluctuations and processing techniques on keeping quality.

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TABLE OF QUALITY ATTRIBUTES (1)

26.9.84		No. of fish defective	No. of fish attacked by rodents beetles, etc.	Fish with mould (%)	Colour of mould	No. of fish infested with pest type	Rancidity	Putrefaction with typical NH4 smell	Remarks
No packaging	0°	2	2	–	–	–	–	–	Very good state
	20°	2	2	–	–	–	–	–	Very good state
	40°	0	0	–	–	–	–	–	Very good state
	60°	2	2	–	–	–	–	–	Very good state
Misty polythene	0°	–	–	100	WG, WGr	–	–	–	
	20°	–	–	80	WGr	–	–	–	
	40°	–	–	10	WGr	–	–	–	Very good state
	60°	–	–	0	–	–	–	–	Very good state
Clear polythene	0°	–	–	100	GB	–	–	–	
	20°	–	–	90	GB	–	–	–	
	40°	–	–	10	WGr	–	–	–	Very good state
	60°	–	–	0	–	–	–	–	Very good state
Aluminium foil	0°	–	–	100	GB	–	–	–	Profuse growth
	20°	–	–	80	WDC	–	–	–	Profuse growth
	40°	–	–	10	WDC	–	–	–	Very good state
	60°	–	–	0	–	–	–	–	Very good state
Brown paper	0°	–	–	70	GB	–	–	–	
	20°	–	–	10	GB	–	–	–	Very good state
	40°	–	–	0	–	–	–	–	Very good state
	60°	–	–	0	–	–	–	–	Very good state
Jute bags	0°	–	–	100	RG	–	–	–	
	20°	–	–	70	RG	–	–	–	
	40°	–	–	40	G	–	–	–	
	60°	–	–	100	WG	–	–	–	

NB: Abbreviations will mean the same for Tables (1), (2), (3) and (4)

RG = Rudimentary growth
G = Greenish mould
WDC = Well developed colonies
GB = Greenish black
Gtw = Greenish white colony
WGr = White grainy
Y = Yellow

0°, 20°, 40°, 60° = Brine strength
NH4 smell = Ammoniacal smell
H/G/G = Head/gut/gill region
TOB = Throughout body
Mod = Moderate

TABLE OF QUALITY ATTRIBUTES (2)

10.10.84		No. of fish defective	No. of fish attacked by rodents, beetles, etc.	Fish with mould (%)	Colour of mould	No. of fish infested with pest type	Rancidity	Putrefaction with typical NH4 smell	Remarks
No packaging	0°	4	2	100	GB patches around Head Region	–	–	–	Attack by rodents and a bit of fouling in and around samples
	20°	5	3	80	Typical green mould	–	–	–	
	40°	2	–	60	Typical green mould	–	–	–	
	60°	3	1	40	Typical green mould	–	–	–	
Misty polythene	0°	–	–	100	GB	–	–	–	Fishy smell
	20°	–	–	100	GB	–	–	–	Fishy smell
	40°	–	–	60	GB	–	–	–	
	60°	–	–	0	–	–	–	–	
Clear polythene	0°	–	–	100	GB, WG	–	–	–	Fishy smell
	20°	–	–	100	GB, WG	–	–	–	Fishy smell
	40°	–	–	65	GB, WG	–	–	–	
	60°	–	–	0	–	–	–	–	
Aluminium foil	0°	–	–	100	GB, WF, WG	–	–	–	
	20°	–	–	100	GB, WF, WG	–	–	–	
	40°	–	–	40	GB, WF, WG	–	–	–	
	60°	–	–	30	GB	–	–	–	
Brown paper	0°	–	–	100	GB, WF	–	–	–	
	20°	–	–	40	GB, WF	–	–	–	
	40°	–	–	20	GB	–	–	–	
	60°	–	–	10	GB	–	–	–	
Jute bags	0°	–	–	100	GB, WF, Y, WG	–	–	–	
	20°	–	–	75	GB, WF, Y, WG	–	–	–	
	40°	–	–	45	GB, WF, Y, WG	–	–	–	
	60°	–	–	20	GB	–	–	–	

TABLE OF QUALITY ATTRIBUTES (3)

24.10.84		No. of fish defective	No. of fish attacked by rodents, beetles, etc.	Fish with mould (%)	Colour of mould	No. of fish infested with pest type	Rancidity	Putrefaction with typical NH4 smell	Remarks
No packaging	0°	5	2	100	G. mould mostly H/G/G	1	Slight	Slight	50–60% infestation
	20°	5	3	100	G. mould mostly H/G/G	–	Stale odour	Very slight	50–60% infestation
	40°	3	–	70	G. mould mostly H/G/G	–	Stale odour	Very slight	35–40% infestation
	60°	3	1	60	G. mould mostly H/G/G	1	Stale odour	Very slight	
Misty polythene	0°	–	–	100	GB, YM, WF, WG	–	–	Very slight	60–70% infestation
	20°	–	–	100	GB, YM, WF, WG	–	–	Very slight	
	40°	–	–	70	GB, YM, WF, WG	–	–	Very slight	50–60% infestation
	60°	–	–	0	–	–	–	–	Extremely good condition
Clear polythene	0°	–	–	100	GB, YM, WF, WG	–	–	–	60–70% infestation T.O.B.
	20°	–	–	100	GB, YM, WF, WG	–	Fishy	–	60–70% infestation T.O.B.
	40°	–	–	75	GB, YM, WF, WG	–	Fishy	–	60–70% infestation T.O.B.
	60°	–	–	0	–	–	–	–	Extremely good condition
Aluminium foil	0°	–	–	100	GB, WF, T.O.B.	Young beetles	–	Very slight	Growth intensified T.O.B.
	20°	–	–	100	GB, WF, T.O.B.	Young beetles	–	–	Growth intensified T.O.B.
	40°	–	–	65	Typical green	–	–	–	Growth intensified T.O.B.
	60°	–	–	55	Typical green GF, Y	–	–	–	Growth intensified T.O.B.
Brown paper	0°	–	–	100		–	–	–	Growth intensified
	20°	–	–	80	Typical green	–	–	–	H/G/G regions
	40°	–	–	70		–	Slight	Very slight	H/G/G regions
	60°	–	–	30	Typical GB	–	Slight	–	H/G/G regions
Jute bags	0°	–	–	100	Typical GB	–	Slight	–	Growth intensified
	20°	–	–	100	Typical GB	–	–	–	H/G/G regions
	40°	–	–	80	Typical GB	–	–	–	H/G/G regions
	60°	–	–	35	Typical GB	–	–	–	Fairly good

TABLE OF QUALITY ATTRIBUTES (4)

7.11.84		No. of fish defective	No. of fish attacked by rodents, beetles, etc.	Fish with mould (%)	Colour of mould	No. of fish infested with pest type	Rancidity	Putrefaction with typical NH4 smell	Remarks
No packaging	0°	5	2	100	GM in H/G/G	–	Mod	–	65% infestation
	20°	5	3	100	GM in H/G/G	–	Mod	–	Growth intensified
	40°	3	–	80	GM in H/G/G	1	Mod	–	Growth intensified
	60°	3	1	70	GM in H/G/G	–	Mod	–	Growth intensified
Misty polythene	0°	–	–	100	GB, YM, WF, WG	–	High	–	
	20°	–	–	100	GB, YM, WF, WG	–	High	–	
	40°	–	–	100	GB, YM, WF, WG	–	Mod	–	
	60°	–	–	35	GB sparingly T.O.B.	–	–	–	Best packaging condition
Clear polythene	0°	–	–	100	GB, YM, WF, WG	–	High	–	
	20°	–	–	100	GB, YM, WF, WG	–	High	–	
	40°	–	–	100	GB, YM, WF, WG	–	Mod	–	
	60°	–	–	45	GB sparingly T.O.B.	–	–	–	Best packaging condition
Aluminium foil	0°	–	–	100		–	High	–	
	20°	–	–	100		–	High	–	
	40°	–	1	90	GB spares	1	Mod	–	
	60°	–	1	80	GB spares	1	Mod	–	
Brown paper	0°	–	–	100	GB spares	-	High	–	
	20°	–	–	100	GB spares	–	High	–	
	40°	–	1	95	GB spares	1	Mod	–	
	60°	–	1	90	GB spares	1	Mod	–	Suitable for short-term storage
Jute bags	0°	2	2	100	GB	–	High	–	
	20°	2	2	100	GB	–	High	–	
	40°	1	1	85	GB	–	Mod	–	
	60°	1	1	60	GB	–	Mod	–	Suitable for short-term storage

NUTRITIONAL EVALUATION OF TRADITIONALLY SMOKED BONGA (*Ethmalosa dorsalis*) AND SAWA (*Sardinella aurita*) OBTAINED FROM DIFFERENT MARKETS IN LAGOS, NIGERIA - A PRELIMINARY INVESTIGATION

by

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ABSTRACT

Smoked bonga (*Ethmalosa dorsalis*) and sawa (*Sardinella aurita*) were obtained regularly from the Lagos State Fish Board and some markets around the Lagos area for the purpose of establishing nutrient losses due to traditional processing of fish so as to alleviate the problems of losses. Preliminary investigation suggests that there were variations due to species and sources of purchase in the proximate composition of different parts of the fishes. Also, slight variation was observed in available lysine and salt contents of smoked fish purchased from different sources. Furthermore, some variations were observed in peroxide value, fatty acid and iodine value and lipid classes.

1. INTRODUCTION

In most tropical countries, particularly Nigeria, chilling is not a common technique of wet fish preservation. However, most of them are used to various traditional forms of smoking or drying for fish preservation. Talabi *et al.* (1980) described various types of traditional smoking techniques and kilns available in the tropics.

Even though salting and drying effectively preserve much of the nutritional value of fresh fish (Aitken *et al.*, 1967) excessive heat treatment is known to impair the nutritional value of fish proteins. Hoffman *et al.* (1977) demonstrated that traditionally prepared hot smoked fish suffer appreciable protein damage from the loss of lysine availability.

While Obileye and Spinelli (1978) were able to minimize loss in lysine availability by gradual removal of moisture from Tilapia, Hoffman *et al.* (1977) reported 71% loss in the lysine content of heavy smoked Sardinella. Although there is ample information on the chemical composition of wood-smoked foods in general, the scientific literature lacks information on the nutritive value of smoked fish, particularly in Nigeria.

Hence, the primary objective of this preliminary study is to assess the nutritional value of cured fish in Nigerian markets so as to provide basic information on traditionally processed bonga (*Ethmalosa dorsalis*) and "Sawa" (*Sardinella aurita*) obtained from different sources in the Lagos area. This would help in developing means of improving on traditional smoking techniques with the ultimate goal of minimizing nutrient losses in such smoked products.

2. MATERIAL AND METHODS

Smoked "Sawa" (*Sardinella aurita*) were purchased from the Lagos State Fish Board (LSFB) and Sandgross market; bonga (*Ethmalosa dorsalis*) was obtained from Maroko market, Lagos. The fish were taken to the laboratory and weighed before manual separation into head, skin, bone and flesh for yield determinations. The flesh was pulverised in a blender, packed in polythene bags and stored in a refrigerator for subsequent chemical analysis.

The crude and total protein, ash and sodium chloride (salt) were determined by AOAC (1975); moisture content was determined by the Dean and Stark (1920) method.

Total lipid and oil extraction were by Bligh and Dyer (1959). Free fatty acid of the oil was estimated according to the procedure of Bligh and Scott (1966), peroxide value was by Lea (1952). Lipid classes were separated using the thin layer plate chromatographic technique (Freeman and West, 1966), quantification was with the aid of the Quick Scan densitometer (Helena Laboratories, USA).

Available lysine and iodine value were estimated according to Carpenter (1960) and Wij's method, respectively.

Conjugated dienes and trienes were estimated by dissolving a known amount of lipid in spectrograde hexane and recording the transmission at 232 and 270 mm respectively using a Beckman spectrophotometer.

3. RESULTS AND DISCUSSION

Table 1 shows the composition of different parts of smoked bonga and sardinella obtained from different sources. It is suggested that there were variations due to species and sources of purchase on the composition with Sardinella from Sandgrouse market having the highest percent flesh and the least percent head.

Table 1

Yield composition of smoked bonga and sardinella obtained from different sources[a]/

Yield characteristic	Bonga from Maroko	Sardinella from LSFB	Sardinella from Sandgrouse
Weight (g)	44.60	25.69	33.82
Head (%)	20.38	12.37	10.48
Skin (%)	17.34	30.52	24.90
Bone (%)	23.72	18.53	16.01
Flesh (%)	38.99	39.82	48.68

a/ Means of 30 pieces of fish each
LSFB = Lagos State Fish Board

The lipid and ash contents varied with the sources of purchase and fish species (Table 2). Sardinella purchased from Sandgrouse market had less percent crude and total proteins than either Sardinella obtained from LSFB or bonga from Maroko. Additionally, Sardinella from Sandgrouse market had the highest moisture content compared with fish obtained from the other locations. The high moisture content could be due to inadequate drying. Traditional smoking time varies between processors (Talabi et al., 1980) and there is no index available for controlling the extent of drying. Furthermore, too rapid an initial drying results in the surface flesh forming a hard crust which slows down the rate of diffusion of moisture from the centre to the outer surface of the fish. This could further explain the high percentage skin, flesh and moisture contents of Sandgrouse "sawa" whose skins were laden with soot and smoke resulting in a hard case.

The salt concentration and available lysine contents of smoked bonga and sardinella obtained from different sources are presented in Table 3. Drying and smoking at high temperatures are known to lower the available lysine contents and the net protein utilization of foods. The available lysine content of Sandgrouse Sardinella was higher than the other two even though the crude form of smoking without regulating the temperature inflicts a lot of damage to the nutrients in fish for example proteins and amino acids are denaturated and destroyed as a result of coupled oxidation and vitamins are destroyed in peroxidizing lipid systems. Andrews et al. (1965) found that many components of oxidized fat could bind probably by hydrogen bonds to proteins at high temperatures. This binding decreases the availability of proteins in diets containing oxidized lipids.

Hoffmann et al. (1977) reported that the lysine content of heavily smoked Sardinella fell to 71% of its original value. However, Obileye and Spinelli (1978) who smoked Tilapia flesh for 12 h at 30°C and dried it to a moisture content of 40% before hot smoking for 12 h at 70°C to 25% moisture. Only minor losses (less than 20%) in the lysine availability of the fish.

Table 4 shows the indices of lipid autoxidation in smoked bonga and Sardinella obtained from different sources. Fish body oils are very susceptible to oxidation by atmospheric oxygen leading to rancid flavours. These flavours may decrease the acceptability of the product. However, the nutritional value of the oxidized fish fat is appreciably lower than that of the fat in the natural form. There is also some evidence that lipid peroxides which are intermediate products of oxidation are toxic and also destroy vitamins A and E.

Table 2

Proximate composition of smoked sardinella
obtained from different sources[a]

Components	Bonga from Maroko	Sardinella from LSFB	Sardinella from Sandgrouse
Crude Protein (%)	71.63	76.3	53.77
True Protein (%)	68.16	68.25	47.95
Lipid (%)	9.00	4.87	4.30
Ash (%)	8.15	5.58	6.48
Moisture (%)	15.50	14.92	38.00

[a] Means of five determinations for each analysis
LSFB = Lagos State Fish Board

Table 3

Salt concentration and available lysine of
smoked bonga and sardinella obtained from different sources[a]

Characteristics	Bonga from Maroko	Sardinella from LSFB	Sardinella from Sandgrouse
Sodium Chloride (%)	0.95	0.83	0.79
Available lysine (g lys/16 g N)	3.18	3.18	3.81

[a] Means of five determinations for each analysis
LSFB = Lagos State Fish Board

Rancidity appears more prominent in bornga than in the Sardinella as bonga has the highest amount of hydroperoxide content which is in accordance with its oil content. However, the low peroxide value of Sardinella from LSFB does not necessarily mean it has less oxidised oil than the others. Hydroperoxides which are the first oxidation products, could produce other compounds after further heating to form compounds not detected by the peroxide value test. A rancid taste often becomes noticeable at peroxide value in the range of 10-20.

Iodine value (IV) is a useful index of the degree of unsaturation of an oil. The less unsaturated fats with low IV are solid at room temperature and oils that are more highly unsaturated are liquids. Hence, there is a relationship between the melting points and the IV. Also, the greater the degree of unsaturation and the higher the IV, the greater is the liability of the fat to oxidative rancidity. Normal animal fats like butter and lard have a IV range of 30-70. The high values obtained for the three fish samples in this study indicate a high degree of unsaturation of their oils. Koizumi *et al.* (1980) showed that the drier the fish the greater is the tendency for the lipids to oxidize.

The free fatty acid (ffa) content measures the extent of lipid hydrolysis by lipase action. The decomposition is accelerated by heat and light. As rancidity could be accompanied by ffa formation, its determination gives a general indication of the condition and edibility of oils. Acidity begins to be noticeable to the palate when ffa calculated as oleic acid is about 0.5-1.5%.

Table 4

Indices of lipid autoxidation in smoked bonga and sardinella obtained from different sources[a/]

Indices	Bonga from Maroko	Sardinella from LSFB	Sardinella from Sandgrouse
Peroxide value (μM hydroperoxide/g)	11.28	6.44	9.90
Iodine value	96.44	133.25	180.39
Free fatty acid (%)	1.92	5.58	11.73
Conjugated diene	-	-	-
Conjugated triene	-	-	-

a/ Means of five determinations for each analysis.
LSFB = Lagos State Fish Board

Talabi (1983) reported very high levels of unsaturated fatty acids in bonga flesh but most was destroyed during processing and storage. It should be noted, however, that while Sardinella from Sandgrouse market had the highest ffa contents, Bonga from Maroko had the lowest value at 1.82%.

Some variations were observed in the lipid classes of smoked bonga and sardinella obtained from different sources (Table 5). The phenolic substances found in wood smoke used for smoking have some antioxidant activity which provides some protection for the oils. Talabi (1983) reported a broad spectrum of hydrocarbons in smoked bonga. The hydrocarbon content of Bonga was higher than in Sardinella. While one cannot relate these findings to the natural hydrocarbons of wood smoke, it can be postulated that smoking as a means of fish preservation increases the hydrocarbon content of the products and that the skin prevents the incorporation of a greater proportion of the aliphatic hydrocarbons into the flesh. It is apparent, however, that only a small amount of hydrocarbon is consumed as the skin is removed before consumption.

In conclusion, it appears that of the traditional curing techniques, only hot smoking leads to any significant protein damage. However, very little is known about the levels of rancidity and toxic substances in our traditionally prepared products and what impact such levels and the smoke absorbed might have on the nutritional value of the fish. This is a high priority research area as recommended by FAO (1981).

It is our belief that with the completion of our future work more conclusive information could be obtained.

Table 5

Lipid classes of smoked bonga and sardinella obtained from different sources[a/]

Lipid classes	Bonga from Maroko	Sardinella from LSFB	Sardinella from Sandgrouse
Phospholipid (%)	24.8	7.5	12.1
Monoglyceride (%)	-	1.1	-
Diglyceride (%)a/	-	10.9	13.7
Triglyceride (%)a/	36.3	-	27.6
Cholesterol (%)	34.4	16.3	23.1
Free Fatty Acid (%)	-	39.1	21.1
Cholesterol Ester (%)	-	4.9	-
Hydrocarbon (%)	4.5	0.2	1.8

a/ Value for LSFB diglyceride and triglyceride are combined because of inadequate separation during scanning
LSFB = Lagos State Fish Board

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A SOLAR-DOME DRYER FOR DRYING FISH

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ABSTRACT

This paper presents the results, analyses and discussions of four experimental trials conducted in the People's Democratic Republic of Yemen, comparing sun-drying and solar-dome drying of three species of fish. Solar-dome drying is shown to be a realistic proposition compared with sun-drying, principally due to the very low losses achievable with solar-dome drying. Technical feasibility of this methodology has been effectively demonstrated and should be supplemented by an economic feasibility evaluation. A description of the solar-dome dryer is also presented.

1. INTRODUCTION

Sun-drying of fish is the most prevalent traditional method of processing fish in the areas of the Red Sea and the Gulf of Aden. Apart from supplying their local demand, countries like Yemen Arab Republic (YAR) and People's Democratic Republic of Yemen (PDRY) exported sun-dried fish until the early 1970s, principally to Sri Lanka. However, the production of dried fish has declined in the recent past due to the increase in the local demand for fresh fish, facilitated by the availability of ice, the low-temperature storage facilities and the improvement in transport and communication facilities. Furthermore, YAR and PDRY lost the valuable export market due to a variety of reasons, but mainly those of poor quality and of problems associated with foreign exchange.

In recent years, fisheries authorities in the countries in the region have attempted to improve methods of production and quality of dried fish, and to reduce losses during drying and storage, as well as providing a quality product to the consumers in their own countries and for export.

The FAO Project for the Development of Fisheries in Areas of the Red Sea and the Gulf of Aden is assisting these countries in the region in:

(a) improving the quality of dried fish;

(b) extending the storage life of the product, and

(c) minimizing losses of the product direct-drying storage and distribution.

It is considered that solar-drying techniques might be more effective than the sun-drying practices traditionally employed, and a prototype solar dryer was designed and constructed at the Galtex Fish Yard of the Ministry of fish Wealth in Aden, PDRY. Initial trials with the solar dryer proved to be promising, but it was considered that before further investment was committed to the Project, a technical evaluation should be undertaken to determine the effectiveness of the dryer and to recommend modifications, if necessary.

2. COMPARISON OF SUN-AND SOLAR-DRYING OF FISH

Sun-drying is the simple expedient of placing fish in the open under the sun and is the most widely employed, easiest and still the cheapest method of drying. However, unhygienic conditions of the processing area, inadequate control of insect activity, exposure to pests and insects, poor packaging methods and poor storage facilities can result in a product of poor quality and considerable losses can be incurred (FAO, 1981).

The potential advantages of solar-drying techniques, compared with sun-drying, can be summarized as follows:

(a) Drying time can be significantly reduced (Curran and Trim, 1982), due to the higher temperatures attainable in solar dryers.

(b) Higher temperatures within the dryer kill or greatly retard the activities of insects such as flies and beetles.

(c) Access to preying birds, cats, and the like is eliminated.

(d) Wind-borne dust that can contaminate the product is effectively excluded.

(e) The combination of higher temperatures and shorter drying times can limit harmful microbiological activity.

(f) Products with lower moisture contents are more easily attainable, which can greatly increase effective storage life (Curran and Trim, 1982).

3. THE SOLAR-DOME DRYER

A solar-tent dryer was developed in Bangladesh some years ago (Doe, et al., 1977). This dryer was intended for individual fishermen dealing with a few kilogrammes of fish, and has been used successfully in other areas (Anedelina, 1978; Curran and Trim, 1982; Richards, 1982). The principle of operation of the solar-tent dryer (Figure 1), is easily appreciated; air enters at ground level along one or both sides, is heated within the dryer aided by the black plastic base and, therefore, rises and exhausts through outlet holes in the apexes at each end. Fish are placed on the perforated racks which are either in the middle or on one side within the tent.

In the Red Sea and the Gulf of Aden region, large quantities of fish are available each day for drying. The solar-dome dryer, built at Caltex Island, Aden (Figure 2), was designed based on the principles of the solar-tent dryer for a handling capacity of 1 000 kg of suitably prepared fish. Essentially, the dryer design is based upon a modern horticultural greenhouse consisting of clear plastic sheet stretched over a metal frame. The majority of the dryer components were supplied by a greenhouse manufacturer (Clovis and Lande Associates, Ltd., Gaza Trading Estate, Hildenborough, Kent, United Kingdom). The greenhouse design was modified by the inclusion of a black base and of inlet and outlet air vents.

The black base is the heat collector. During the initial trials, a black plastic sheet was laid over a concrete base, but the insects - both adult and larvae - found shelter in the shaded and, therefore, cooler areas and in the folds of the plastic sheet. For the second series of trials, the plastic sheet was replaced by black painted galvanized iron sheets to reduce these problems.

The inlet air vents are positioned at ground level along the full length of both sides. The outlet air vents are positioned along the top of the dryer. Both inlet and outlet vents are fitted with fine plastic netting to reduce the entry of insects and animals. The inlet vents are also provided with a plastic flap fastened from the top to provide rudimentary control of airflow. Cardboard slats over the outlet vent are also used to control the flow of air since strong winds sometimes force air into the dryer through these vents.

Flat-bed drying, even though it is convenient and requires less labour, would reduce the capacity of fish that could be accommodated inside the dome. Hanging fish from beams by their heads or tail would facilitate better air circulation and a greater quantity of fish can be contained within the dryer. Black-paint coated wooden frames for the beams are installed within the dryer dividing it into ten bays; five on each side of the control accessway. Each bay is 1.6 m^2 in area. Four such bays are left empty and used as surfaces for solar absorption, and six are used as drying bays (Figure 2). Wooden beams with 26 hooks on either side are used to hang the fish. Each bay can accommodate up to 42 beams in six rows. Wooden trays for flat-base drying can be used; however, the size of the trays would narrow down in the upper rows.

4. MATERIALS AND METHODS

Four drying trials were carried out, using three species of fish: horse mackerel (Arabic: bathabath) - Scomber japonicus, goat fish (Arabic: abusinna) - Nemipterus japonicus and catfish (Arabic: komal) - Arius thallassinus. Fresh fish were not readily available; therefore, supplies had to be obtained from the cold stores of the National Corporation for Fish Marketing (NCFM). Packs of frozen fish were transported by truck to the drying yard, thawed as quickly as possible in tanks of water, processed if necessary, packed with dry salt in concrete tanks (pickle-salting), and left overnight before being removed for drying (however, for the first trials fish had to be kept in the salting tanks for approximately 42 h). After salting, the beams and/or trays were loaded in the processing area and then carried either to the solar dryer or to the sun-drying area.

Bathabath were dried in the first trial in four batches on hooks and on trays inside the solar-dome dryer, on hooks and on wooden slatted tables for sun-drying. Sun-drying on wooden slatted tables was the usual practice in the Caltex drying yard. Bathabath were also used in the second trial with fish being dried on hooks both inside the solar dryer and by sun-drying. In the third trial abusinna were used. Two batches were dried on hooks in the solar dryer; one with the beams widely spaced and the other with the beams closely packed. A third batch was sun-dried on hooks. Komal were used in the fourth trial: one batch on hooks in the solar dryer, with the beams widely spaced and the other also on hooks by sun drying. Table 1 provides detailed data on the techniques used in the four trials.

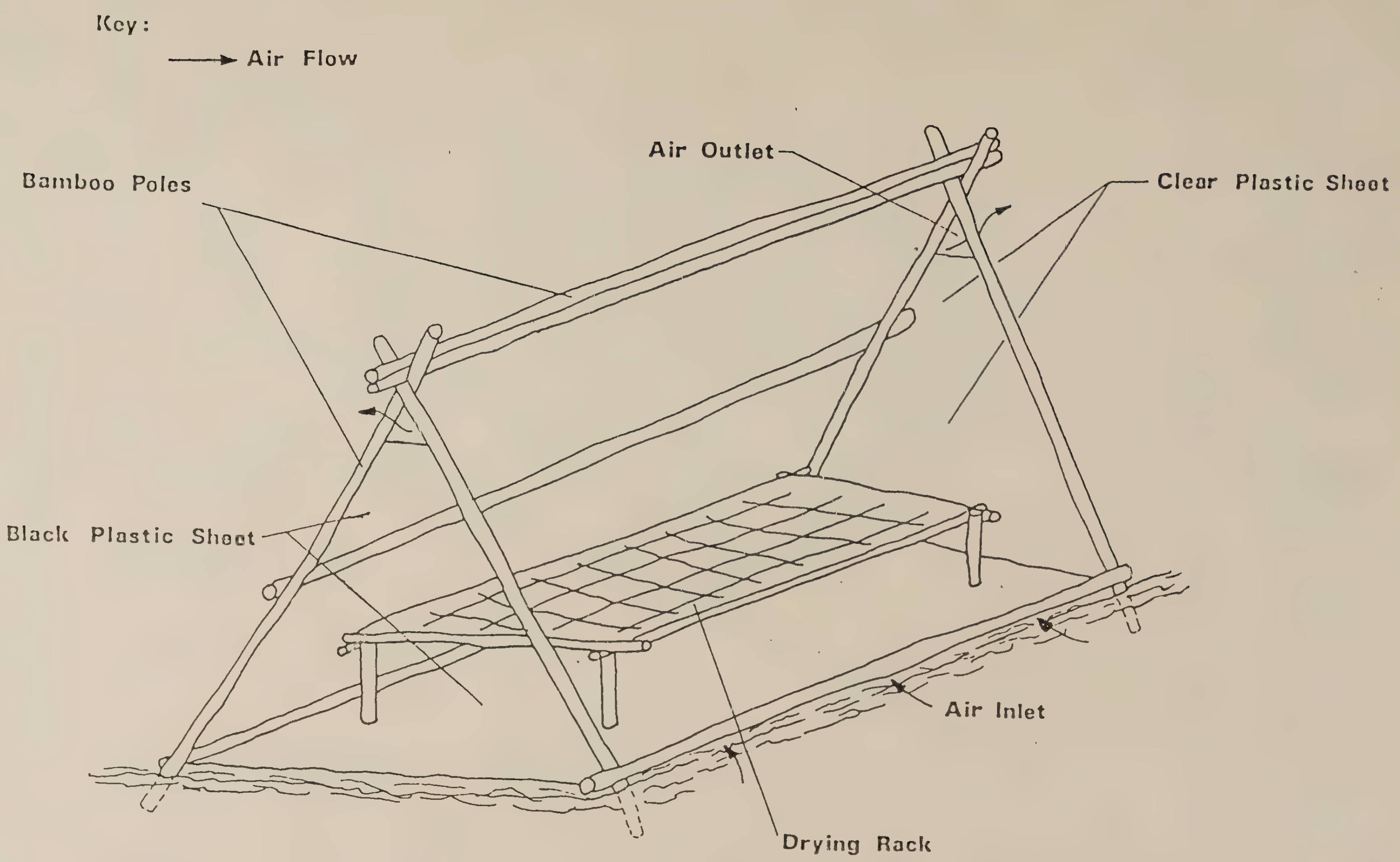
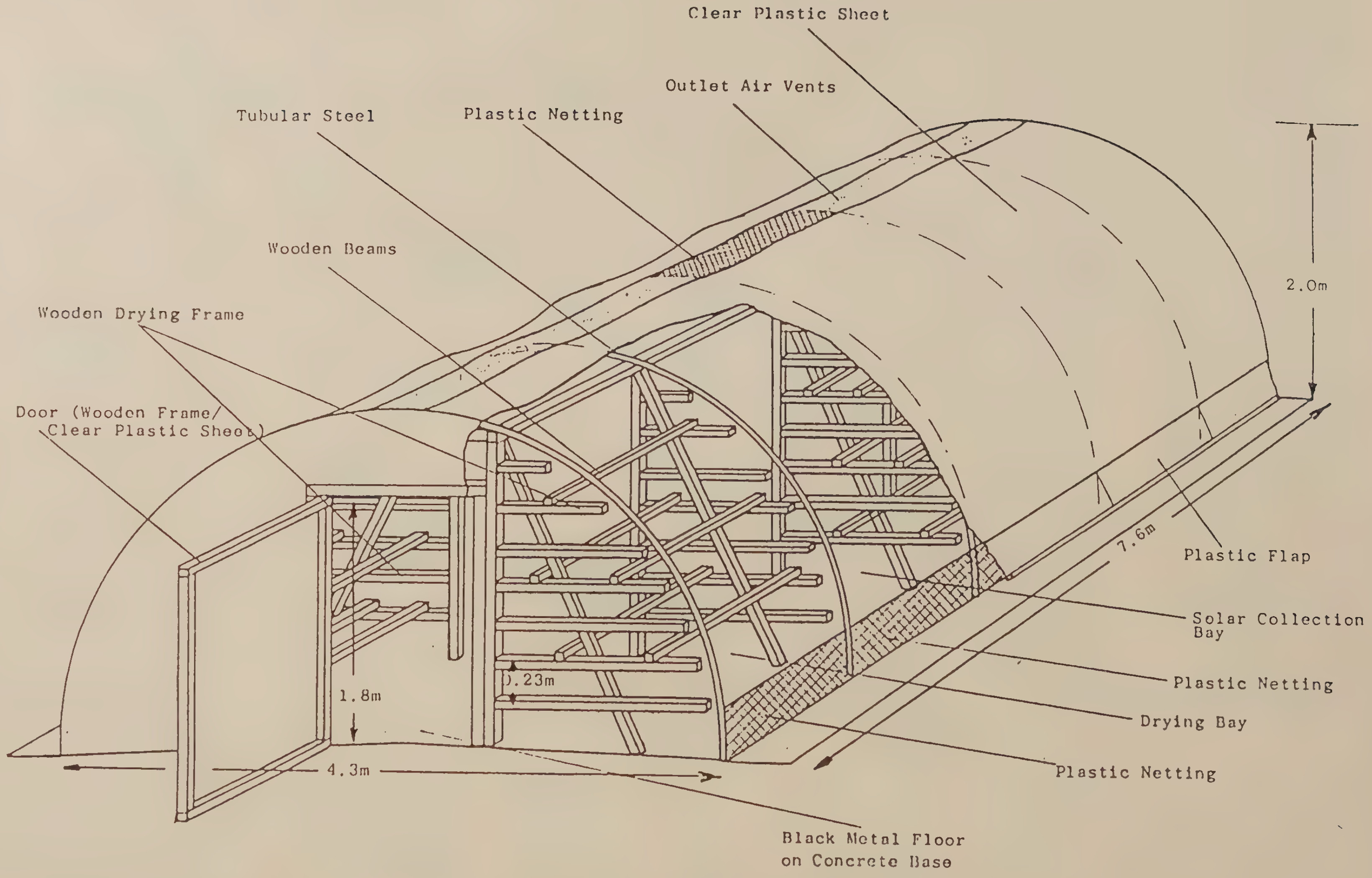

Key:
Air Flow
Bamboo Poles
Air Outlet
Clear Plastic Sheet
Black Plastic Sheet
Air Inlet
Drying Rack

Figure 1 Diagram of the polythene-tent dryer (Doe, et al., 1977)


All Dimensions Approximate

Clear Plastic Sheet
Outlet Air Vents
Tubular Steel
Plastic Netting
Wooden Beams
Wooden Drying Frame
Door (Wooden Frame/
Clear Plastic Sheet)
2.0m
7.6m
Plastic Flap
Solar Collection Bay
Plastic Netting
Drying Bay
Plastic Netting
0.23m
1.8m
4.3m
Black Metal Floor
on Concrete Base

Figure 2 Solar-dome dryer - Aden

Drying rates were monitored both by regularly weighing selected batches of fish and by measuring muscle moisture content, using an infrared moisture balance. Air temperatures both outside and at various positions within the dryer were continuously recorded during daylight hours, using a six-point chart recorder. Temperature and humidity recordings were also made at selected locations using chart thermo-hydrographs. Cumulative measurements of isolation were obtained with a dome solarimeter and integrator, and those of wind speed with a cup anenometer.

In addition to these physical measurements, careful observations were made of the condition of each batch of fish as it dried and, also, of the effects of flies and beetles upon the fish.

Table 1

Experimental trials

Trial	Species	Drying Method	Quantity Used, kg		Salt Used kg	No. of Beams/ Trays	Spacing m	Dried Fish	
			Fresh	Prpd				Mass kg	Loss* %
1	Bathabath	1. Solar/ Hooks	-	280	--	48	0.3	13.2	1-2
		2. Solar/ Trays	N/R	36	N/R	3	0.25	R/T	-
		3. Sun/ Hooks	N/R	28	N/R	5	0.3	R/T	ca100
		4. Sun/ Slats	N/R	10	N/R	1	-	R/T	ca100
2	Bathabath	1. Solar/ Hooks		47		8	0.3		0
		2. Sun/ Hooks		7		1	0.3		
3	Abusinna	1. Solar/ Hooks	405	17	148	3	0.3		0
		2. Solar/ Hooks		242		43	0.15		50
		3. Sun/ Hooks		17		3	0.3		
4	Catfish	1. Solar/ Hooks	351	150	123	21	0.3	92	0
		2. Sun/ Hooks	16	7		1			

N/R - not recorded

R/T - Termination of trial due to excessive insect, putrefaction etc.

* Loss of fish defined as proportion of dried product considered as of unsaleable quality

5. RESULTS AND DISCUSSIONS

It was unfortunate that for most of the period of the trial, extremely unusual climatic conditions were encountered. An average insolation of 9.5 MJ.m^{-2}.day^{-1} was recorded for the period of 9-21 February, compared with a usual figure of about 20 MJ.m^{-2}.day^{-1} (Howell and Bereny, 1979). However, for the last few days of the trials, more typical weather was experienced and an indication obtained of the probable performance of the solar dryer under typical regional conditions.

The air temperature recorded at the upper levels within the dryer of fine sunny days, with insolation of about 15 MJ.m^{-2}.day^{-1} and with the flaps over the inlet air vents closed, exceeded 40°C for about eight hours a day (08.00-16.00 h), and 45°C for about five hours (10.00-15.00 h), during which the ambient air temperature was about 29°-33°C (Table 2). The air temperature inside the dryer varied within 1°-3°C with lower temperatures near the base and the door area, and with higher temperatures at the centre and at the upper layers.

Table 2

Air temperature (°C) inside (upper layers) and outside the solar dryer during the trials

Date	Ambient temperature °C Min.	Ambient temperature °C Max.	Internal dryer temperature °C Min.	Internal dryer temperature °C Max.	No. of hours internal dryer temp. above 40°C
7.2.83	–	–	–	44.5	–
8.2.83	25	32	25	45	8
9.2.83	25	34	24.5	47	7
10.2.83	25	30	25	37	–
11.2.83	22	29	21	33	–
12.2.83	25	33	23.5	46	8
13.2.83	25	33	24	52	8.5
14.2.83	25	30	24	42	6
15.2.83	21.5	30	22.5	44	6
16.2.83	23	31	23	45	6
17.2.83	23.5	32	23	49	8.5
18.2.83	23	34	24	47	8
19.2.83	25	31	25	45	5
20.2.83	–	–	24	45	2
21.2.83	–	–	–	–	–
22.2.83	–	–	23	39	–
23.2.83	–	–	23	47	9
24.2.83	–	–	23.5	47	8.5
25.2.83	–	–	24	47	8.5

Drying curves for the four trials are illustrated in Figures 3-7. It must be noted that with the exception of the fourth trial, the drying curves were untypical because of the unusually inclement weather. Some of the sundried batches were prematurely terminated, particularly in the first three trials because of the excessive insect infestation and/or putrefaction.

The rate of drying was generally greater in the sun-dried fish during the first two days than that of those inside the solar dryer due to the greater flow of air around the former. However, the drying rate during the later stages, i.e., at low moisture contents, was greater inside the dryer than that outside. This can be observed from the drying curves. This result is in agreement with the generally accepted drying theory (Waterman, 1976), in which internal moisture diffusion is considered the rate-controlling factor at low moisture levels. Diffusion is very temperature dependent and, therefore, the higher temperature attained within the solar dryer would cause higher drying rates.

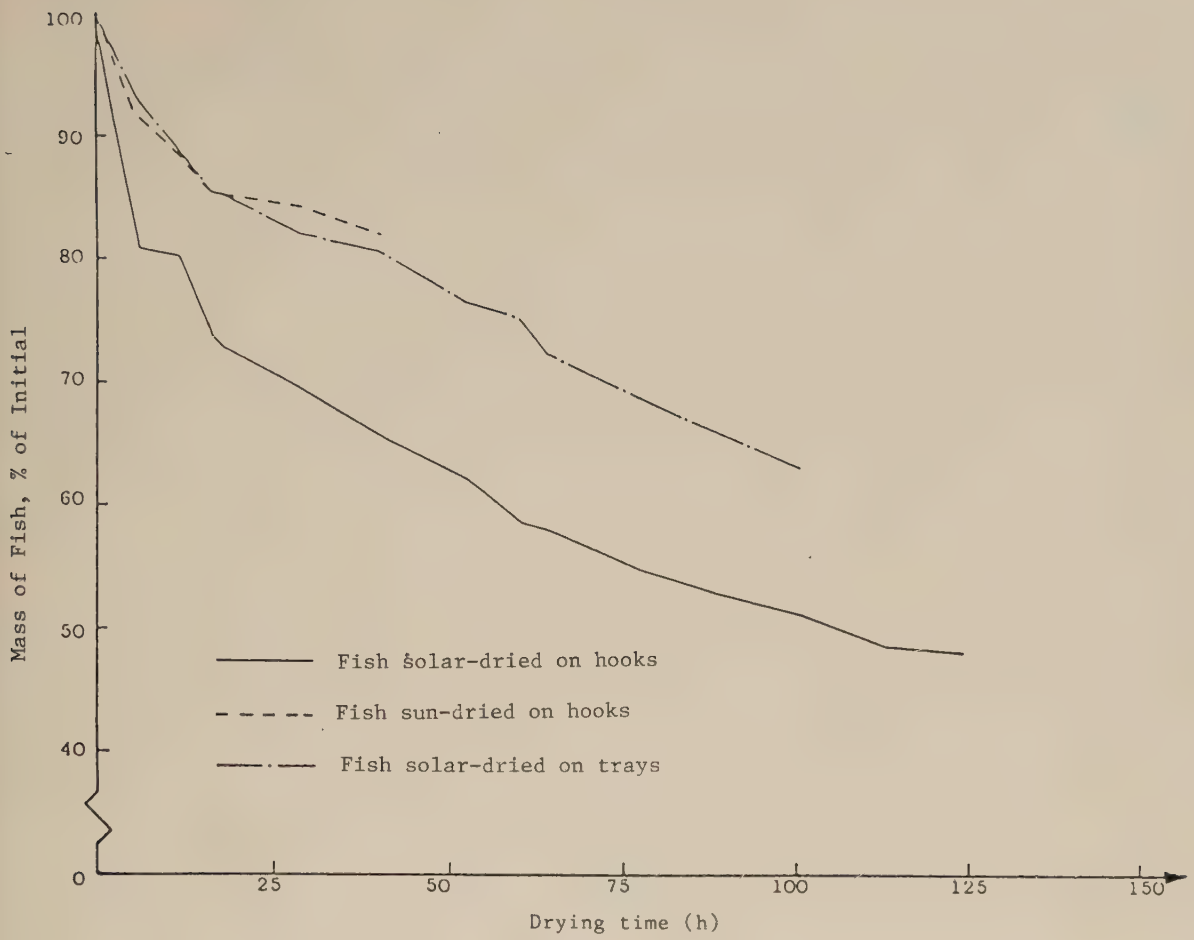


Figure 3 Drying curves for bathabath (Trial 1)

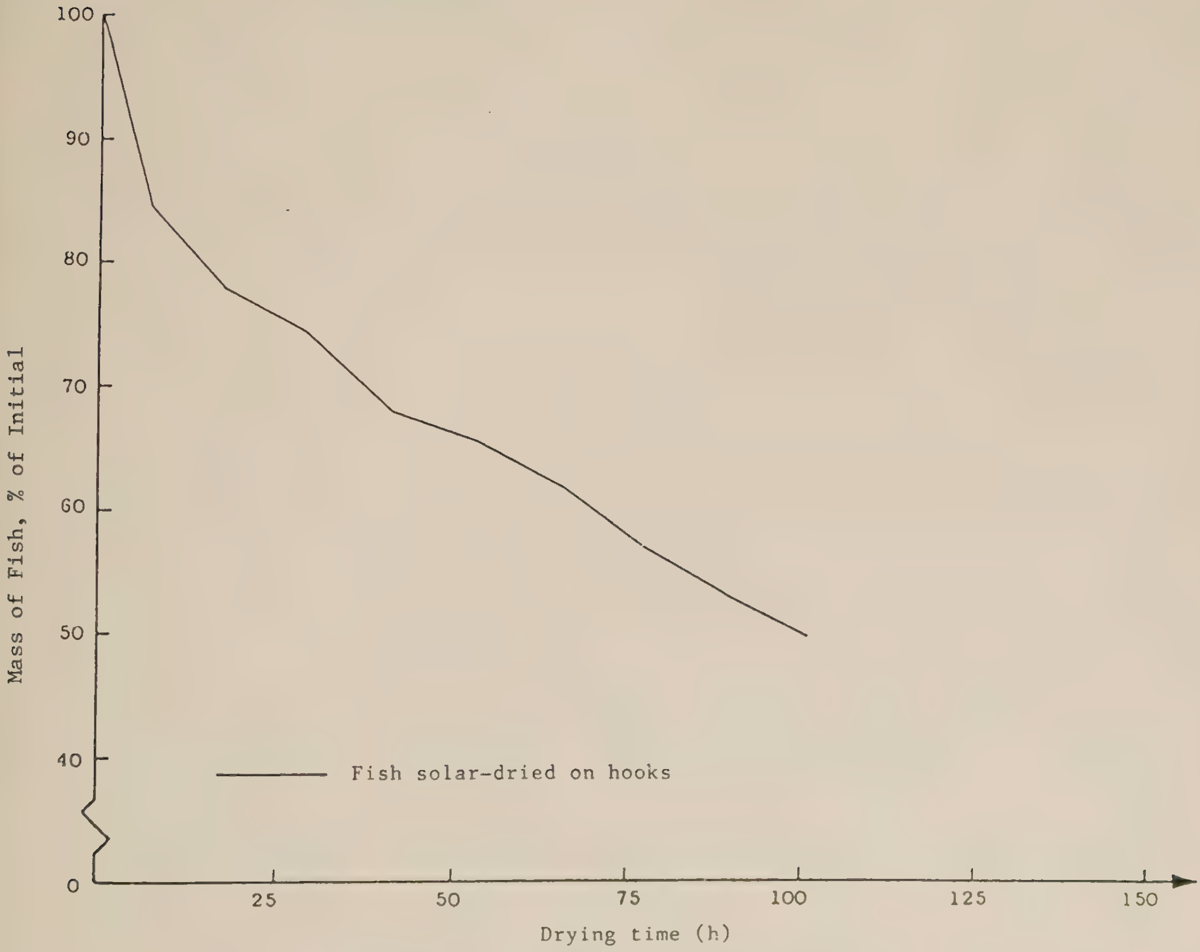


Figure 4 Drying curve for bathabath (Trial 2)

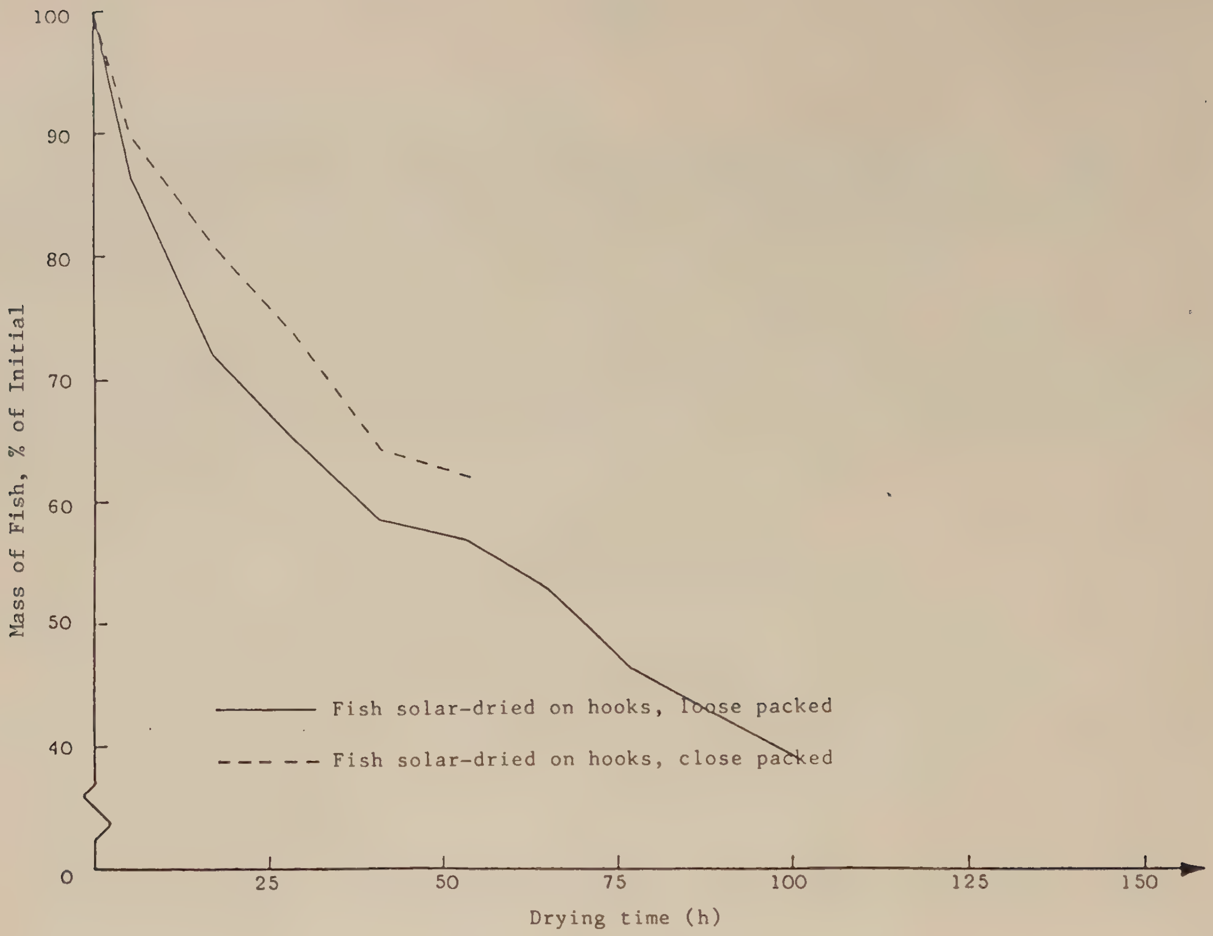


Figure 5 Drying curves for abusinna (Trial 3)

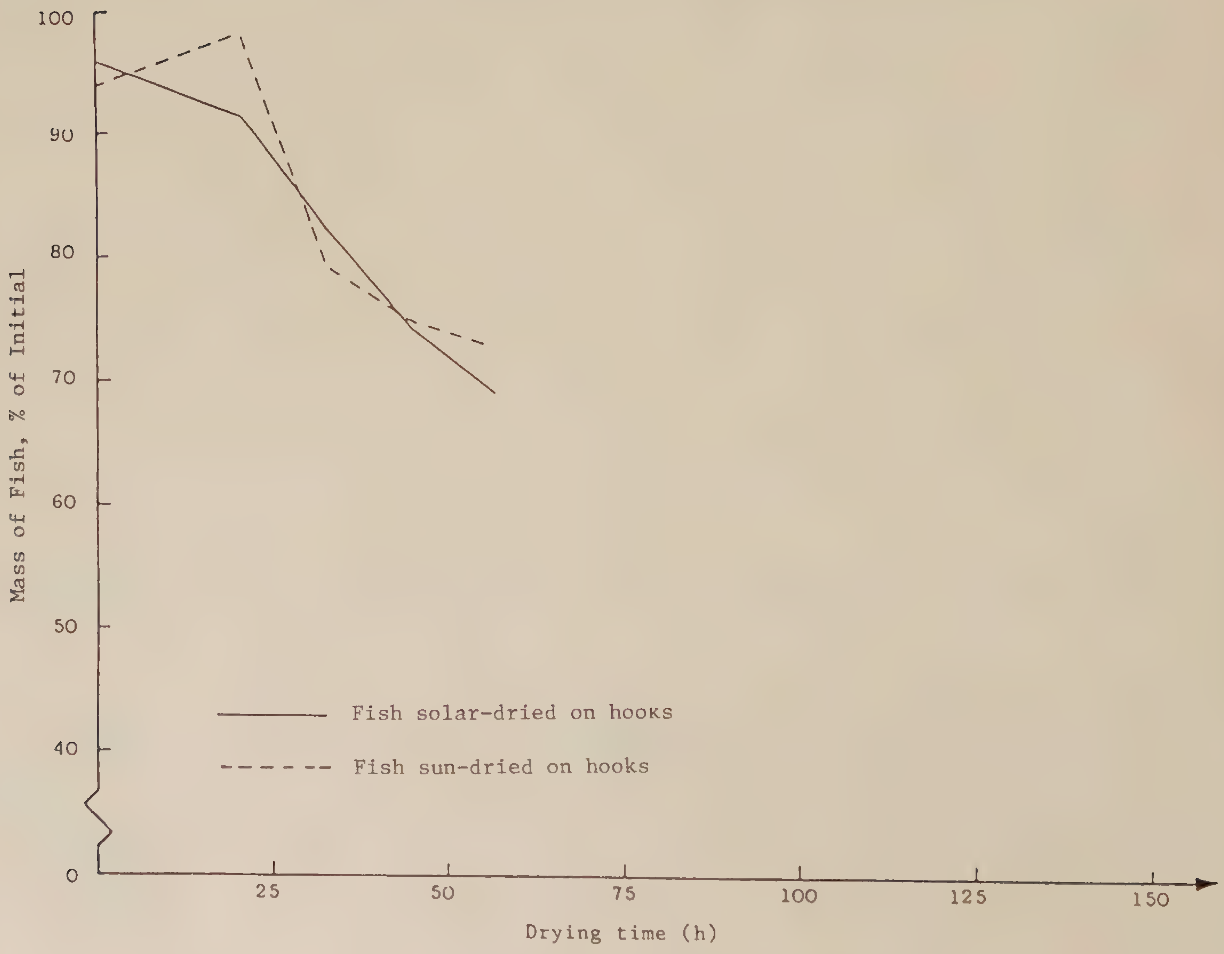


Figure 6 Drying curves for komal (Trial 4)

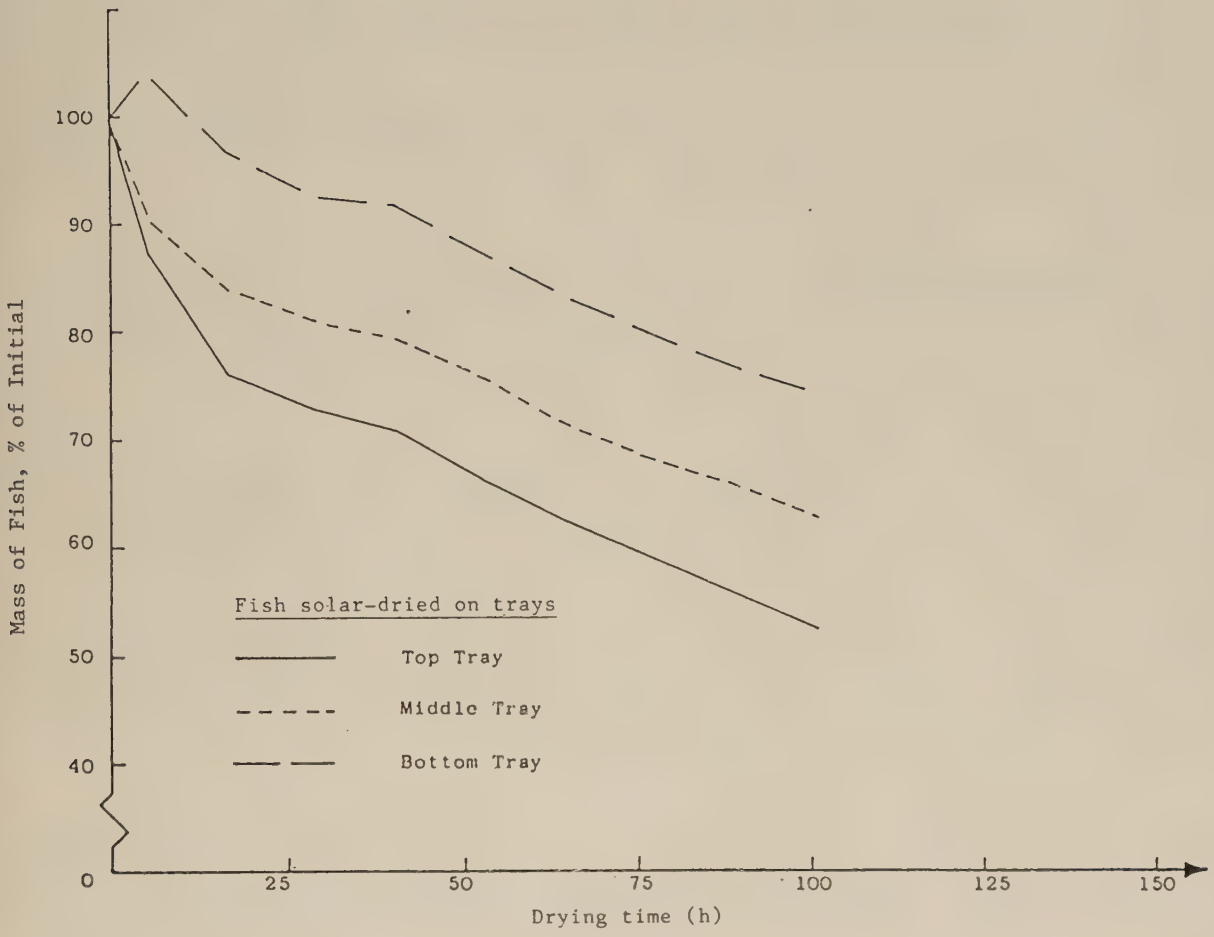


Figure 7 Drying curves for bathabath (Trial 1)

From Figure 3 it can be seen that the rate of drying for fish hung on hooks was considerably greater than the average drying rate of fish loaded on a tier of three trays. Figure 7 illustrates the drying curves for fish on each of these three trays. As might be expected, the drying rate of fish spread on the uppermost tray was significantly greater than that of the fish on the middle tray which, in turn, was appreciably greater than that of the fish on the bottom trays.

Insect activity during the trials presented an interesting comparison. On a day when insolation was low, the insect activity was high. Batches of sun-dried fish hung on hooks were eaten up by the larvae of Chuysonya megacephala Fab., the common filth fly. Most of the sun-dried fish were lost to these larvae during the initial drying period. Eggs were laid on the exposed parts of the fish during salting and hatched into larvae during the first two days of drying. Eggs were also laid during the first day of drying. However, when insolation was relatively high, the insect activity was reduced. Inside the dryer, filth flies entered unnoticed through the door during loading. Also, eggs laid during salting hatched into larvae which, at temperatures above 40°C, fell to the floor of the dryer to creep towards cooler and shaded areas. The high temperatures of the metal base, even in shaded areas, killed most of the larvae falling to the floor. A few larvae pupated into adults but these were later killed by the high temperature. Entry and exit of adult flies during loading was effectively restricted by the plastic mesh over the air vents. Losses due to filth fly activity inside the solar-dome dryer were extremely low during the trials.

The beetle Dermestes frischii Kugelmann entered the processing area with the powdered salt. These beetles were found in fish inside the salting tank. Adults and larvae were not observed during sun-drying on the hanging fish, whereas they were found inside the solar dryer. The adults clustered around the cooler areas, around the air vents, during daytime when temperatures inside the dryer became intolerable. The number of larvae and adults of beetles dying increased day by day.

It is unrealistic to expect complete elimination of insect infestation within the dryer, but there were very promising indications that the insect population inside the dryer could be kept to reasonable limits. During the initial trials with the black plastic base, the insects tended to hide themselves in small openings, crevices, folds of plastic and shaded areas. There was also a tendency for insects to hide in the cracks of the wooden framework and by the inlet air vents. Better control of insects could be achieved with the limited and indirect use of insecticides (but not applied to the fish), by fumigating the dryer before and after use, and other good housekeeping practices.

The lower quality of dried fish produced in the region, owing the adherence of dust and sand to the product, is the result of sun-drying the fish on the open sand, exposing them to the frequent sand and dust storms. The solar dryer provided the required cover to prevent such contamination; the solar-dried product had neither sand nor dust on it. Losses owing to drying in the open sand or on wooden salted tables as in the Caltex drying yard, are heavy mainly due to the preying of birds, cats and dogs. Bathabath sun-dried on the first trial both on hooks and on the slats, suffered greatly from these effects resulting in almost total losses. Birds, cats or dogs cannot enter the solar dryer, and unlike the sun-drying method, losses are extremely small.

Lower levels of moisture content (20-25% w.b.) were achieved for products from the solar dryer than were achieved in the sun-dried products (25-35% w.b.). Moisture re-absorption was evident during the later stages of solar drying of komal; the fish had droplets of water lining their lowest region at dawn, and the weights increased by 2-3% at dawn compared with those at dusk the previous day.

The most striking feature of the trials was the difference in quality of the dried fish produced in the solar dryer and by sun-drying. With the exception of abusinna, in the third trial the quality of the fish dried on hooks in the solar dryer was extremely good, being well and evenly dried, of pleasant odour and with little evidence of rancidity or of microbial or insect attack. The quality of solar-dried bathabath and komal was considered to be superior to that generally produced in the Red Sea and the Gulf of Aden region. The yield of good quality solar-dried fish was, therefore, extremely high with only a small proportion of the product considered not of the highest quality. However, in the third trial with abusinna, in which the beams were closely packed in a drying bay, it was found that the fish in the middle of the pack dried very slowly probably due to poor airflow and excessive localized humidity around the fish resulting in considerable losses - about 50% - due to putrefaction.

As might be expected, the quality and yield of sun-dried fish was considerably lower (Table 1), although this was not doubt exacerbated by the unusual weather. Bathabath dried in the first trial both on hooks and on the slats suffered greatly from insect infestation, particularly filth flies. Fish sun-dried in subsequent trials in better weather did not suffer so greatly from insect attack, but overall quality of the dried product was poorer than that of solar-dried fish. Officials of the Ministry of Fish Wealth estimated that sun-drying losses could be as high as 40-50% and, generally, of a lower quality than that obtained in the solar dryer. The product obtained by sun-drying during the trials was almost certainly of significantly higher quality than the sun-dried product generally obtained in PDRY.

It should be remembered that all the trials were carried out using thawed frozen fish. During freezing and subsequent thawing it might be expected that some degree of protein denaturation would occur resulting in a small loss of moisture. Drying times with freshly caught fish might, therefore, be expected to be slightly longer than those recorded in the trials. Despite having to use frozen fish for the trials, it was still possible to obtain solar-dried fish of the highest quality.

The quantity of fish that could be loaded into the solar dryer depends on the size of the fish and its preparation. It is evident from the trials that for fish above a certain size, i.e., 150 mm in length, drying on hooks is the most efficient method of utilizing the available space. The thickness of fish should not exceed 15-17 mm, if it were to be hooked whole. All fish above this thickness must be split and scarified for salting and drying. Bathabath and abusinna were hooked whole. Komal was split and scarified prior to salting for hooking. Very small fish can be hung two to a hook.

Optimal quantity for whole or prepared fish will be the 150-175 kg of fish in each of the six bays. With such density it can be expected that fish can be dried to a moisture of 25% in about four days in normal weather. Allowing one day for unloading and reloading, i.e., an operating cycle of five days, the dryer is capable of a throughput of approximately 200 kg of fish per day.

Solar-dried fish were observed to be devoid of insects during the post-noon hours (13.00-15.00 h), as most of the inesects were either killed or hiding. The dryer was unloaded and the drier fish packaged in polythene bags during these hours to avoid packing insects with the product. Once the polythene bags were sealed, the chances of insects reaching the dried fish are reduced, unless storage conditions permit insects to gain access through the packaging. Eggs laid by the beetles Dermestes frischii on the product before packaging can hatch inside the package though very few beetles were still seen inside the package after three months of storage of the solar-dried fish.

6. CONCLUSIONS

(1) A modified horticultural greenhouse can be successfully used to dry fish.

(2) Shorter drying times inside the solar dryer restrict biochemical and bacterial action, giving marked reductions in losses.

(3) Restricted access and unfavourable environment within the solar dryer reduces insect infestation and associated losses.

(4) The elimination of birds and animals results in prevention of theft of fish and the associated losses.

(5) Hanging fish on hooks inside the dryer provides a greater throughput than drying them on layers of trays.

7. RECOMMENDATIONS

(1) The optimum size of a solar-dome dryer for commercial purposes seems to be one that takes in a maximum load of one tonne of prepared fish at at time.

(2) Fish 150 mm and longer should be used for hooking. If the thickness of the fish exceeds twenty mm, it should be split before hooking.

(3) Limited powdered insecticide is recommended for sprinkling around the base of the dryer. However, knowledgeable persons should be consulted regarding the type, quantity and method of use of any insecticide.

(4) The door of the dryer must, as far as possible, be kept closed.

(5) The opening of the air vents should be adjusted to allow maximum air circulation around the fish during the first two days of drying. Air temperatures should be controlled to be 45°-50°C during the final stages of drying.

(6) Removing the product for packaging should always be carried out during the afternoons to avoid contaminating the product with insects.

(7) The heat collection area should always be kept clear and without curves. It should not be used as a storage area. At no time should the dryer be shaded.

(8) Good house-keeping practices are essential to achieve efficient use of the dryer. Proper maintenance and care of the various parts of the dryer are equally essential.

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TESTING A SOLAR DOME FISH DRYER IN THE GAMBIA

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ABSTRACT

Heavy losses of traditional cured fish are incurred in the Gambia due to insect attack during drying and storage. In an attempt to improve processing and reduce blow-fly infestation, a one-ton prototype solar dome dryer was constructed and tested at Brufut, one of the major coastal artisanal fish landing and processing sites. Several drying trials were carried out using five different species with the intention of preparing products suited to the local market. The performance of the dryer was compared with sun drying on traditional, flat chicken wire and sloping chicken wire racks. The solar dome did not perform as well as expected from the results of trials on similar designs elsewhere. Very similar drying rates were obtained for sun and solar dome drying. The poor performance was attributed to the nature of the raw material (i.e., fermented fish) used to prepare guedja, the local dried product, and the weather. In addition, blow-fly infestation was a problem if sufficient care was not taken to prevent the entry of flies into the dryer. Low initial temperatures had to be used in the dome to avoid cooking the fragile raw material so that improved drying rates could not be achieved. These temperatures were too low to kill either the adult blow-flies which gained access to the dryer or any larvae that hatched from eggs laid on the drying fish. The dull, wet weather made it difficult to attain and maintain higher temperatures when these were required during the later stages of drying.

1. INTRODUCTION

The artisanal marine sector is the most productive fishery in the Gambia. In 1981, over 12 000 t of fish were landed by artisanal fishermen, 11 000 t of this by the marine sector. In comparison, the industrial fleet landed 7 600 t during the same year (Drammeh, 1981). Most of the artisanal catch is cured and traditional processing is practised at the major sites.

About 35% of the marine artisanal catch is the pelagic fish, bonga (Ethmalosa fimbriata). Most of this is smoked or sold fresh. Locally, dried fish is called guedja. It is a fermented product and is usually salted. Many species are used to prepare guedja, particularly catfish. Bonga or mullet may be used to produce a fermented guedja product known locally as tambajang. Sharks and rays are also fermented and dried as are sea snails (yete); the latter are never salted. White fish (cassava fish, ladyfish, barracuda, grouper and sole) are usually sold fresh although some may be cured.

During a survey of the losses incurred in traditionally cured fish at larger artisanal landing sites and processing areas (TDRI, unpublished data), it was noted that insect infestation of drying fermented fish and stored dried fish was a major problem. Several areas requiring research were highlighted. As a result, several collaborative projects between the local Fisheries Department, the Food and Agriculture Organization (FAO) and the Tropical Development and Research Institute (TDRI) were undertaken. The areas under investigation included improved processing (e.g., solar dryers, better salting techniques, etc.) and the use of insecticides.

In recent years, there has been considerable interest in the use of solar dryers as an improved method of drying fish in developing countries. By achieving higher temperatures and reduced relative humidities, solar dryers can increase drying rates, produce lower moisture contents in the final products and improve product quality compared with traditional sun drying. They can also provide protection against attack by the blow-flies and beetles which cause considerable damage to dried fish. The principles of solar dryers and their advantages over traditional sun drying have been discussed in more detail elsewhere (Löf, 1962; Saulinier, 1976; Trim, 1982; Trim and Curran, 1983; Sachithananthan, Trim and Speirs (1983).

The solar dryers so far used with fish have been of fairly low capacity (Chakraborty, 1976; Doe et al, 1977; Meynell, 1978; Pablo, 1978; Deng et al., 1979; Ismail, 1980 and 1983; Mercado Aguiar, 1980; Ahmed et al., 1981; Richards, 1982; Camu et al., 1983; Trim and Curran, 1983). It is only during the last few years that larger solar dome dryers have been investigated. Kent (1980) constructed a solar dome dryer (6 x 6 m) in Mali. Then Sachithananthan (1984) and his co-authors (1983) tested a one-ton capacity dryer in Aden and Bostock and Mosquera (1984) conducted trials with a 0.5-t capacity dome in the Galapagos Islands. This paper reports on the testing of a one-ton prototype solar dome dryer, the design of which was prepared following the work in Aden. It was constructed on Brufut beach, the third largest artisanal landing and processing site along the Gambian coast.

2. EQUIPMENT AND METHODS

2.1 Solar Dome Dryer

The solar dome dryer is a prototype supplied by Clovis Lande Associates Ltd. (Gaza Trading State, Hildenborough, Kent, UK), following work carried out by FAO/TDRI in Aden by Sachithananthan, Trim and Speirs (1983 and 1984). The design is based on a horticultural greenhouse. It consists of clear plastic sheet stretched over a metal framework, with side and top vents, and a black concrete base sloping to both side (Figure 1). The black base is the heat collector. Air enters at ground level through the side vents and is heated in the heat collector areas. The heated air passes over the surface of the fish, removing water as vapour, rises and exhausts through the roof vents. All the vents are covered with black plastic mesh and have sliding panels to control the airflow and temperature within the dryer. The dome is divided into heat collection bays and fish drying bays, alternating with each other, and a central corridor for loading and unloading. The fish are usually hung on hooks which are fixed to removable drying beams in the drying bays. The solar dome dryer is available in a range of sizes; the model used in this experimental programme was 4.26 m wide x 7.56 m long x 2.0 m high. It had five bays along each side, three for drying and two for heat collection.

2.2 Sun-Drying Racks

The double sloping rack was constructed from chicken wire spread over a wooden framework. One flat rack was built in the local traditional manner with a wooden frame and the central ribs from palm fronds for the drying table. The second comprised a concrete frame with chicken wire spred over it.

2.3 Fish Preparation

Five different species were used during the drying trials: catfish (Arius gambiensis and A. mercatorius); ladyfish (Pseudotholithus senegalensis); bonga (Ethmalosa fimbriata); shark and sea snails (both unidentified species). The main objective of the drying trials was to prepare dried products which were suited to the Gambian and Senegalese markets and, therefore, local preparation methods were followed. However, some possible improvements to the methods and alternative products were investigated to determine whether these would be acceptable to local consumers.

The products were all dressed according to local custom. The catfish and ladyfish were split while the bonga were descaled, gutted and gilled. The flesh of the sea snails (yete) was cut into four flaps and the gills were removed. Since very large shark were used, the flesh was cut into pieces averaging 700 g in weight: these were scored.

The catfish were salted by four different methods; the traditional technique of sprinkling the surface with salt after the fish had been allowed to ferment (i.e., spoil) overnight, in saturated brine for 30 min, or in either 10 or 50° brine overnight. The ladyfish were soaked in saturated brine for 30 min. Bonga were either dry salted according to the local method or placed in 50° brine overnight. Dry salting involved filling the body cavity and "coating" the skin with salt; the fish were then left in a pile overnight and any pickle which formed was allowed to drain away. Neither the shark nor the yete were salted.

For solar drying, the fish were usually hung from hooks on the drying beams. The split fish were hung from the tail using speats to stop them folding but bonga were hooked through the eyes. The traditionally salted catfish and the yete were more suited to drying on trays. For sun-drying comparisons, the products were spread on one or more of the racks.

2.4 Operating Procedure

With the exception of the shark, the products were dried until they were considered by local processors to be ready for the local market. The sark were dried until no further weight loss was found. During drying, batches of fish from each drying method were weighed at regular intervals (usually three times each day unless it was raining). During the course of the trials, a record was kept of the condition of the fish as they dried. At night, the solar dried fish were left in position in the dome and the sun dried fish were placed in a pile and covered with hessian sacking and plastic sheeting.

Weather permitting, measurements were taken at hourly intervals from 09.00 to 17.00 hours of the following: insolation using a solarimeter and integrator (Lintronic Ltd., 54-59 Bartholomew Close, London, UK); ambient and internal dryer temperatures with a temperature recorder (Grant Instruments (Cambridge) Ltd., Barrington, Cambridge, UK); ambient humidity with a wet and dry bulb hygrometer (C.F. Casella and Co. Ltd., Regent House, Britannia Walk, London, UK); and wind speed using an anemometer (C.F. Casella and Co. Ltd.). During the earlier trials, humidity inside the solar dome was also measured but this was discontinued to decrease the number of times it was necessary to enter the dryer and, thus reduce the entry of flies.

2.5 Final Product Analysis

For each batch of the final products from the drying trials, the flesh from several fish was minced and duplicate samples were taken from the pooled muscle for moisture and salt analysis. Moisture content was determined by drying 2-5 g sample in a convection oven at 105°C for 24 hours. The chlor-o-counter (Marius Instrumenten, P.O. Box 7018, Utrecht, Holland) silver electrode titration technique was used for the salt determination. Dried samples of each of the species investigated were also analysed for fat, protein and ash content (AOAC, 1965).

3. RESULTS AND DISCUSSION

The drying trials were carried out during June 1984 at the start of the rainy season. The frequency and amount of rainfall increased toward the end of the work and more dull weather was encountered. Generally, there was very hazy sunshine in the morning and it became either sunny or cloudy with rain in the afternoon. Over the 8-h period when measurements of the operating conditions were taken, the mean ambient temperature was 31°C (range 25-35°C) and the relative humidity was 76% (48-89%). The total daily insolation averaged 16 MJ m^{-2} and the mean wind speed on Brufut beach was 11 km h^{-1}.

The drying curves obtained during the trials are given in Figures 2-5. The moisture and salt contents of the final dried products are given in Table 1 and the proximate analysis of the different species in Table 2. As can be seen from these results, the solar dome dryer did not perform as well as expected: very similar drying rates were obtained for sun and solar dome drying. Generally, 2-3 days of good drying weather were necessary to prepare a product suited to the local market. There were two main reasons for this poor performance: firstly, the nature of the raw material used to prepare the local product, guedja, and secondly, the poor weather conditions.

Although the methods used for preparing guedja vary slightly with species and also between one processor and another, they all require fermented fish. Generally, the women processing guedja will buy spoilt fish in the late afternoon when it is cheaper. This will be dressed and salted immediately and left in a pile overnight on the drying rack before being set to dry the next day. If, for some reason, they have to buy good quality fresh fish, the women will bury it in clay pots in the ground and leave it overnight to "ferment" (i.e., spoil). The following morning, the fish would be salted and set to dry on the racks. Consequently, the material which is to be dried is very soft and fragile. In addition, catfish, the main species used to prepare guedja, were about to spawn at the time that the dryer was being tested so that the flesh was even more delicate which worsened the situation. Fish which are salted by the traditional method of sprinkling salt on the surface are not suited to hanging in the solar dryer since the salt would fall off. Since this method also gives an uneven salt penetration, several brining methods were studied to determine which would be suitable for the local market. A fairly moist product is preferred.

During the first drying trial o catfish and ladyfish (Figures 2A and 3A), the temperature in the solar dome was kept at 40-45°C on the first day of drying. Both species started to cook and break up during solar drying. As a result, the fish became misshapen, with gaping holes appearing due to the weight of the fish dragging on the hooks. Pieces of flesk broke off and fell onto the floor of the dryer. There was some evidence of case hardening in the solar dried ladyfish.

Table 1

Moisture and salt contents (wet weight basis) of final dried products

Species	Salting method	% Moisture		% Salt	
		Sun[a] dried	Solar dried	Sun[a] dried	Solar dried
Catfish	Traditional salting	39.92	50.03	28.81	27.80
	100° brine, 30 min	54.15	51.79	8.47	4.75
	50° brine, overnight	45.92	46.01	8.24	8.16
	10° brine, overnight	47.81	-	2.82	-
Bonga	Traditional salting	56.18	58.38	17.60	12.98
	100° brine, overnight	55.04	57.79	8.83	5.65
Ladyfish	100° brine, 30 min	58.79	64.28	3.30	7.19
Yete	Unsalted	60.51	66.39	3.35	3.51
Shark	Unsalted	30.95	36.44	3.23	4.15

[a] Mean of all sun dried products if more than one rack was tested

Table 2

Proximate analysis (dry weight basis) of the species[a] studied

Species	% Fat	% Protein	% Ash	% Salt
Catfish	1.89	59.09	15.81	14.06
Bonga	4.16	68.37	20.30	16.46
Ladyfish	1.53	81.58	18.48	14.07
Shark	0.15	98.88	7.30	5.53
Yete	1.11	51.95	14.72	9.38
'Melting' yete	0.32	72.36	25.68	11.25

[a] The final products were used for the analysis

Following this, during the drying of the brined catfish (Figures 2B and C) an initial lower temperature was used (30-35°C) in the solar dome which was increased in stages to avoid cooking. It was concluded that the following drying regime should be followed when producing guedja in the solar dome:

Day	Ventilation	Temperature (°C)
1	Full	30-35
2	Fairly high	35-40
3	Low	40-45
4	Low	45-50

During the later trials, it was often found to be difficult to follow this regime due to the poor weather conditions. After the first drying day, the vents were kept closed in the morning until the required temperature was achieved in the dome. Unfortunately, the higher temperatures were regularly not reached until midday. The vents were then selectively opened, and toward the end of the afternoon closed again, to maintain the higher temperature. Consequently, drying at the required temperature was only possible for about 4 hours each day. While testing the earlier design of this dome, Sachithananthan, Trim and Speirs (1983) had similar problems with poor weather. They were able to exceed 40°C for about 8 hours each day (08.00-16.00 hours) and 45°C for about 5 hours (10.00-15.00 hours) only on fine sunny days.

Very poor weather was encountered during the drying of the traditionally salted catfish and unsalted yete. This trial had to be terminated prematurely due to the Eid el-Fitr religious holiday. Consequently, these products were not sufficiently dry for the local market: the former would have required about one more good drying day and the latter two more (Figures 4A and C). Trays had been prepared for the solar dome and these were tested during this trial since the products are not suited to hanging in the dome.

The weight loss data for both the traditionally salted catfish and bonga should be treated with caution since some of the salt remaining on the fish could be lost during handling. All of the batches of sun dried yete samples contained at least one sample of "melting" yete. This is a different species which is less acceptable to the local market and it is not always identifiable during preparation; the snail flesh starts to shrivel and turn black after a few hours' drying. Analysis of the "melting" yete (Table 2) indicated that these had a different composition to the non-melting species so that the weight loss data will not give a true indication of the moisture loss from the main species during sun drying.

It was expected that using the sloping rack would produce the highest sun drying rates, the traditional rack the lowest, with the flat rack in between these two. However, a comparison of the drying rate and moisture content data from all of the trials indicated that none of the racks appeared to perform consistently better or worse than the other.

It was found that heavy maggot infestation occurred if the entry of adult blow-flies into the solar dome dryer was not restricted. The 10° brined catfish samples (Figure 2C) were found to be heavily infested with blowfly maggots after three days in the solar dome and were discarded. The sun-dried fish were also adversely affected but to a lesser degree.

Most of the adult flies entered the solar dome during loading. Following this, the temperatures inside the dryer would have been ideal for hatching of the blow-fly eggs and far too low to kill the larvae (FAO, 1981). During sun drying most of the maggots would migrate inside the fish during the day and the incident sunlight would kill any remaining on the surface within a few hours. To overcome this problem, after unloading and washing the dome, the temperature inside was raised to 50°C for several hours before the next batch of fish were loaded. In bad weather when this was not possible, the dryer was sprayed inside with a domestic insecticide one hour before loading. During loading, as many beams as possible were taken into the dryer at a time; this was usually five beams between two people with a third person to open and close the dryer doors. The dome was then opened as little as possible during operation.

4. CONCLUSIONS

Sachithananthan, Trim and Speirs (1983) obtained higher drying rates using the earlier design of the solar dome dryer in Aden and were able to achieve a marked reduction in losses due to spoilage and insect infestation. In the Gambia, however, the solar dome dryer was less successful: very similar rates were obtained for sun and solar drying of several different products and blow-fly infestation could be a problem. This was not considered to be a consequence of the minor changes in design.

There were two explanations for this poorer performance. Firstly, the raw material for the local dried product, guedja, is fermented (i.e., spoiled) before drying; it is very fragile and cooks and falls to pieces if it is dried at high temperatures initially. Consequently, it is necessary to start drying at ambient temperatures within the dome; the temperature is then increased gradually in stages to 50°C as the moisture content is reduced. During the later stages of drying when high temperatures could be used to increase the drying rate considerably, the product was sufficiently dry for the local market. Secondly, the dryer was tested at the beginning of the rainy season and the weather worsened during the course of the experiment period. It was often difficult to achieve and maintain the higher temperatures within the dome when they were required.

If steps were taken to kill all flies in the dome before loading the fish and care was taken to keep their entry into the dryer to a minimum during loading and operation, it was possible to decrease maggot infestation during drying. However, if flies did enter the dome, the conditions inside were ideal for hatching and development of maggots since high temperatures could not be used during the initial stages of drying. Under these circumstances, considerable losses were incurred. In Malawi, it was found that the performance of natural convection solar dryers in reducing blow-fly infestation during the wet season was generally disappointing (TDRI, unpublished data). They also found that some of the dryers tested achieved temperatures which were sufficiently high to reduce infestation but this led to cooking of the fish. A forced convection dryer was more successful in controlling infestation but reduced the drying rate and allowed some spoilage to occur. Several other workers (Doe et al., 1977; Ahmed et al., 1981; Ismail, 1983; Trim and Curran, 1983) have found natural convection solar dryers very efficient in reducing losses due to blow-fly infestation during good weather. Haque (1982) reported that, in Bangladesh, further work undertaken with the solar tent dryer developed by Doe et al. (1977) and tested in the dry season produced similar results in the wet, humid season.

Work on the solar dome dryer in the Gambia is continuing. Several women from Brufut Village have been assisting with the processing and it is hoped that eventually they will be able to take over the commercial operation of the dryer. This further work will show whether improved drying rates may be obtained at other times of the year. It will also be used with non-fermented products which may be suited to drying at higher initial temperatures.

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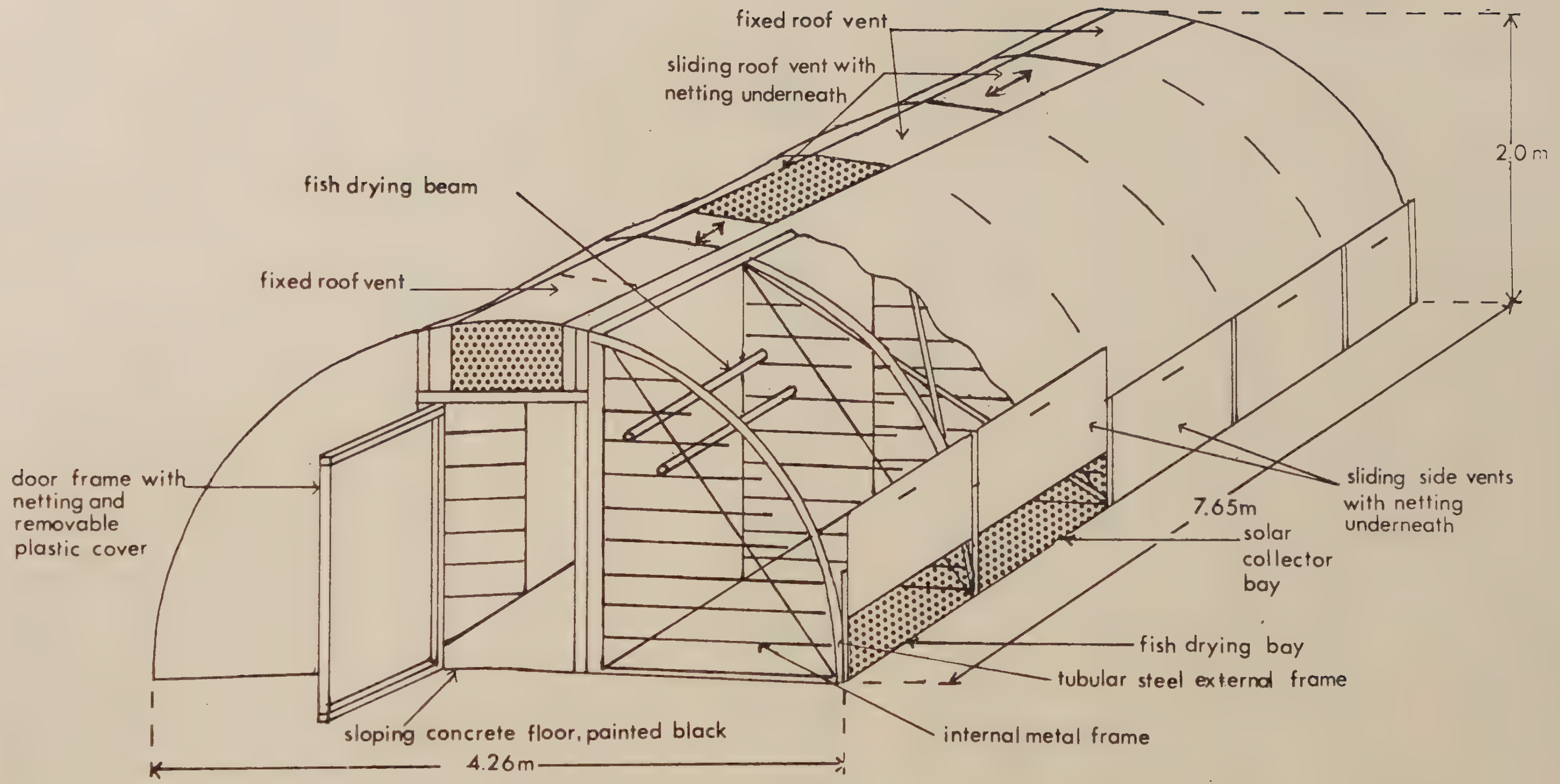
fixed roof vent
sliding roof vent with netting underneath
fish drying beam
fixed roof vent
2.0 m
door frame with netting and removable plastic cover
sliding side vents with netting underneath
7.65m
solar collector bay
fish drying bay
tubular steel external frame
sloping concrete floor, painted black
internal metal frame
4.26m

Figure 1 Solar dome dryer

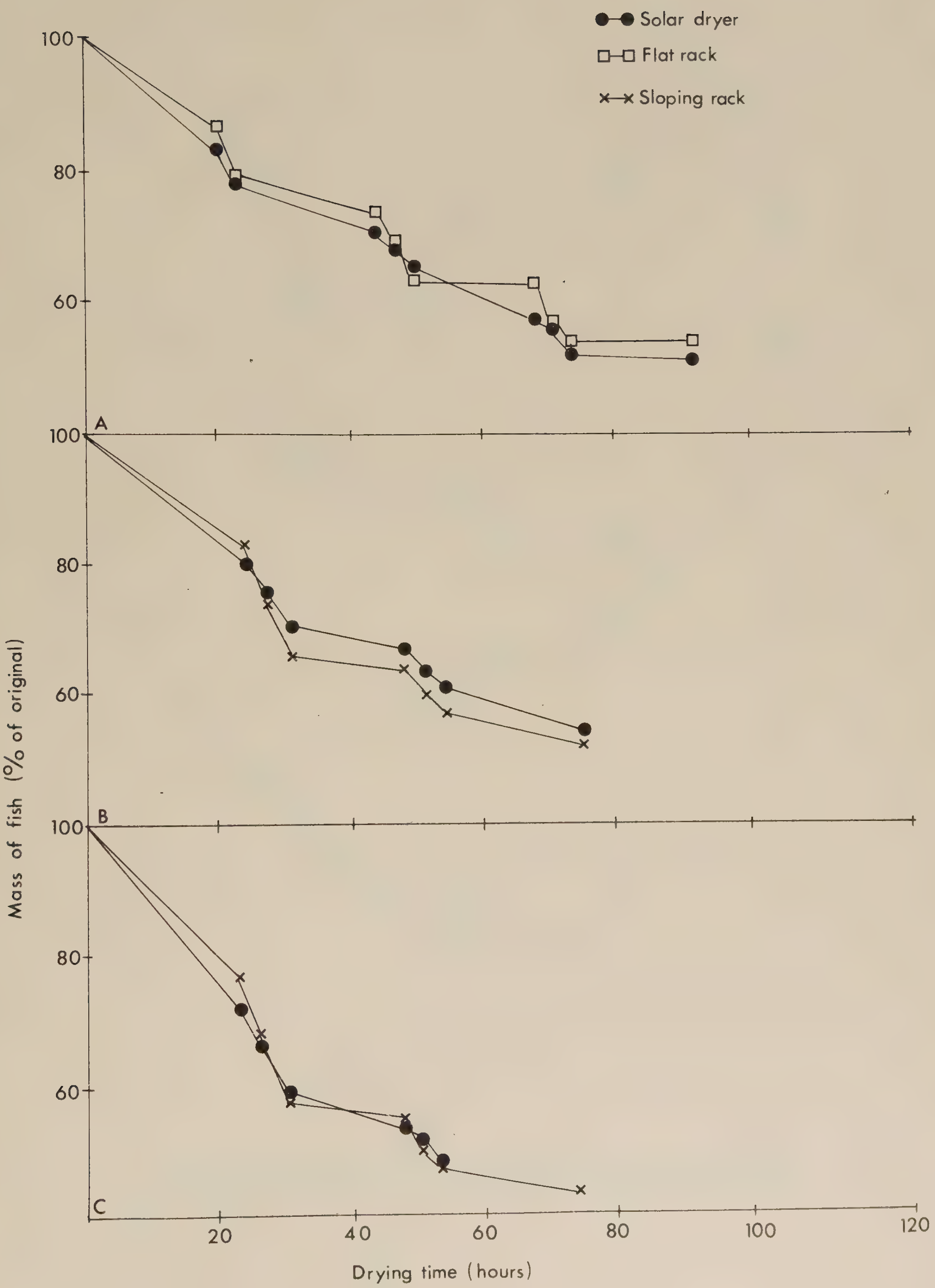

Figure 2 Drying curves for catfish salted for (A) 30 min in 100° brine, (B) overnight in 50° brine and (C) overnight in 10° brine

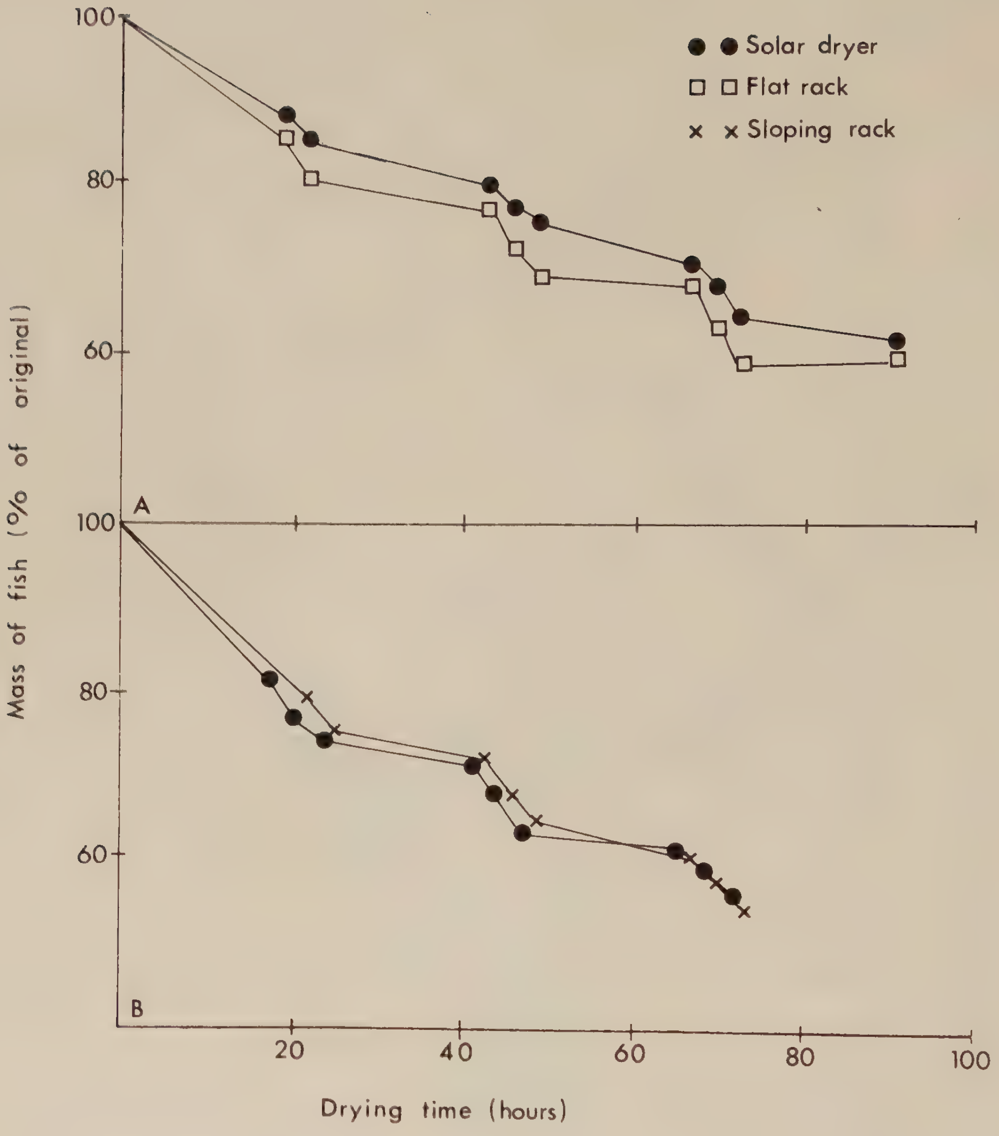

Figure 3 Drying curves for brined (A) ladyfish and (B) bonga

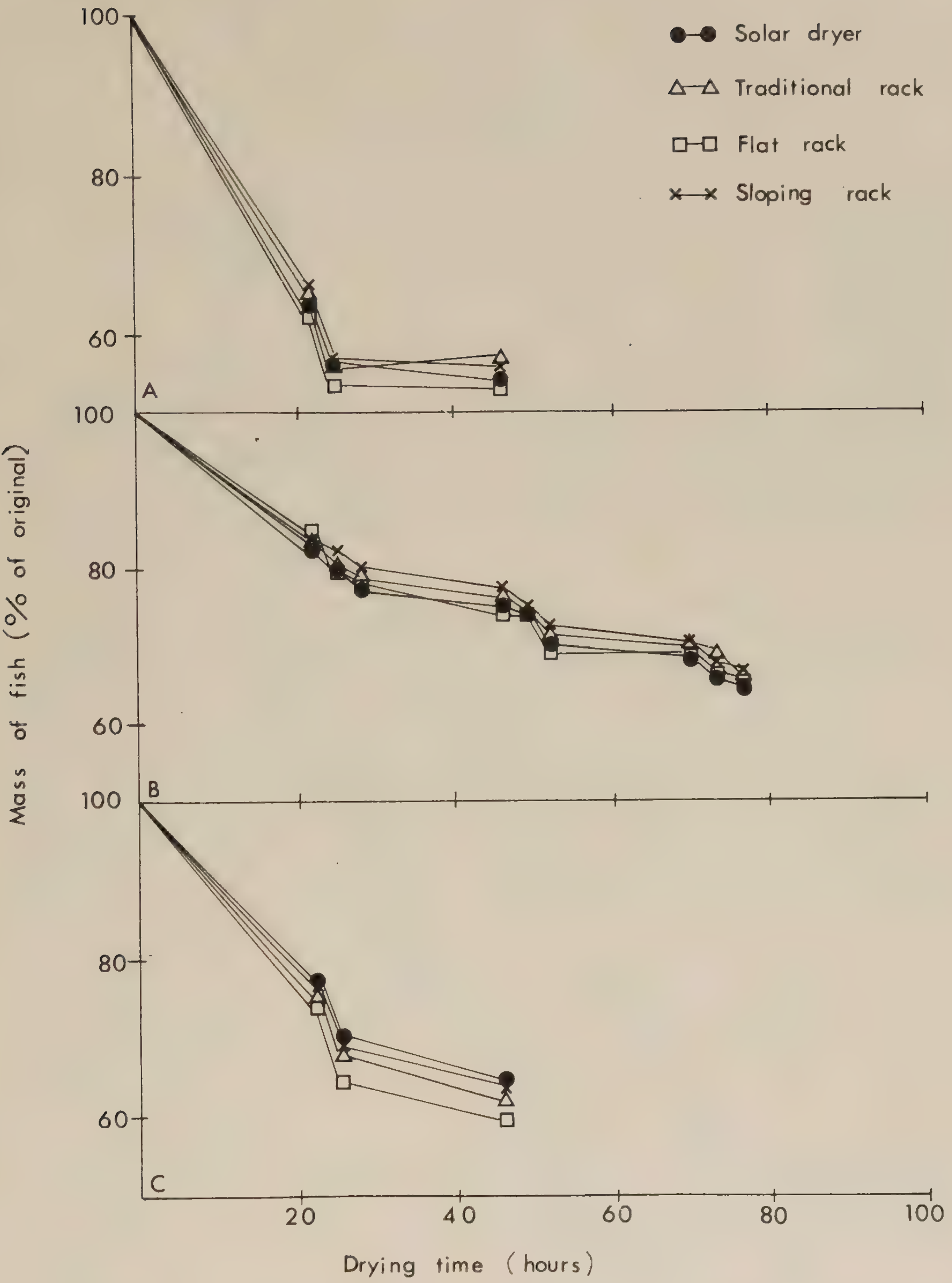

Figure 4 Drying curves for traditionally prepared (A) catfish, (B) bonga and (C) yete

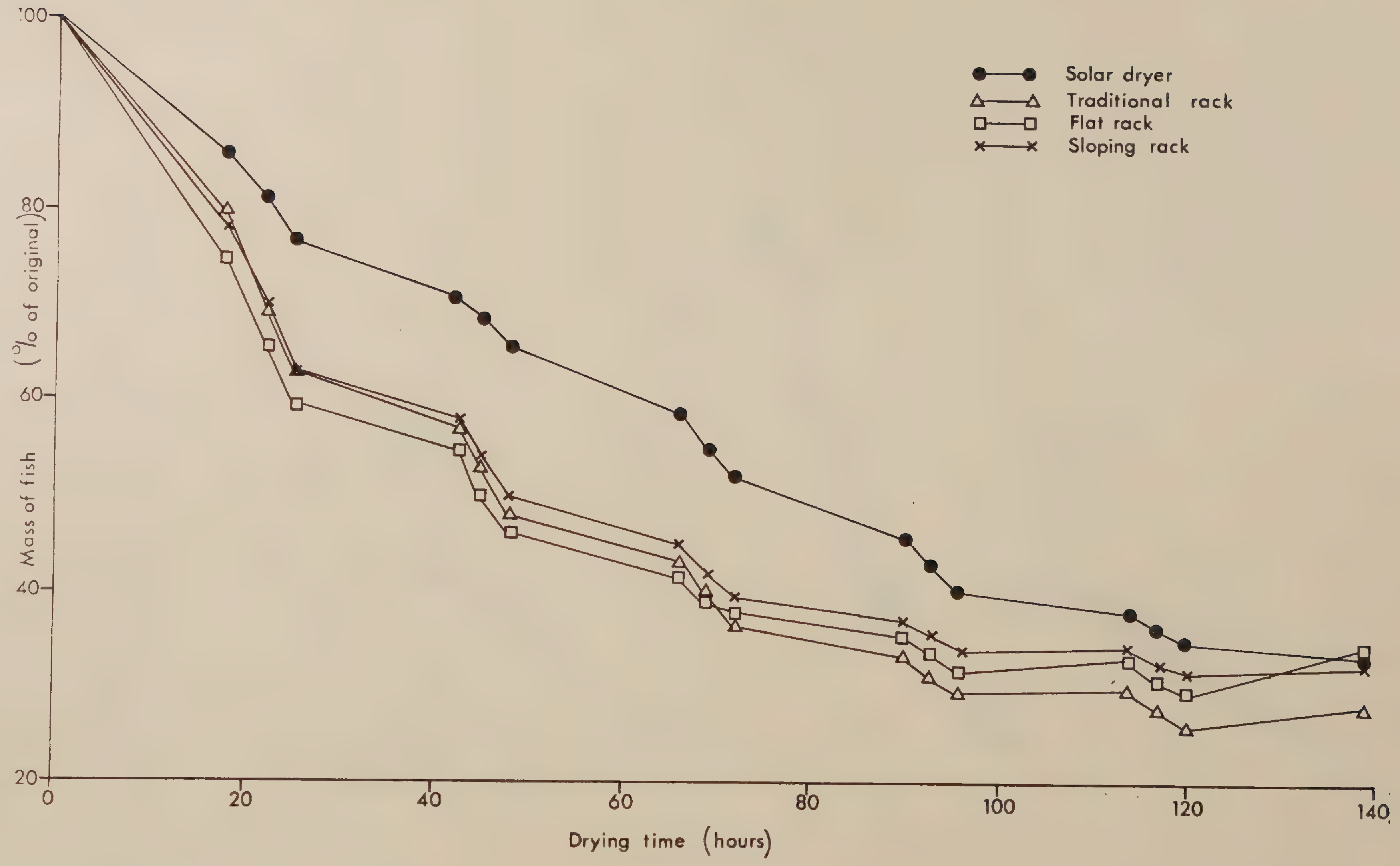

Figure 5 Drying curves for unsalted shark

FERMENTING AND DRYING FISH IN THE GAMBIA
(Considerations and possible impact of commercial solar drying in the artisanal fisheries sector)

by

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ABSTRACT

To reduce post-harvest losses in fish and fishery products the improvement of traditional processing technology in the Gambia cannot be overstated.

The Government has recently been making strong efforts to develop artisanal fisheries and to increase catches by expanding productive efforts through the distribution of inputs, such as gears and outboard motors, on a revolving loan scheme. It is foreseen that with increased catch-landings the traditional processing sub-sector would be more intensive involving drying and smoking since freezing, icing and cold-storage facilities are deficient in the country.

Given this situation and the fact that presently a substantial amount of the total annual landings is subject to sun drying, the use of solar dryers has been investigated to reduce the problems associated with sun drying. Fish-drying is a widely known practice in the Gambia, done mainly to prevent spoilt demersal fish landed by artisanal fishermen from deteriorating further.

Demersal fish are caught with setnets, and because the catch is left in the waters for relatively long periods deterioration begins at sea. During the hot season when sea-water temperatures are between 25° and 30°C, the problem of landing spoilt fish is worse. It is thought that the amount of spoilt fish landed each year ranges between 35% and 75%, depending on the season. Although attempts have never been made to systematically quantify losses, eye-estimates from various and numerous observations suggest that losses are quite high and insect infestation prevalent. The problem of infestation becomes acute during the rainy seasons.

Pelagic fish, such as E. fimbriata (bonga), Sardinella spp., and Arius spp., are normally smoked but, either because of their seasonal abundance or because of the eating habits of people, they are sometimes also sun-dried. Sharks and rays and other underutilized species are sun-dried and stored in large amounts mainly for export to neighbouring countries.

Realizing the magnitude of fish-drying activities in the artisanal sector, and the limitations and problems in the traditional processing techniques, it has been prudent to embark on a solar-drying project, assuming that no matter how little the difference might be, the use of solar dryers for drying fish will play a vital role in reducing losses and improving quality in dried-fish production.

It is in this direction, therefore, that experiments were conducted with the assistance of FAO on the use of a commercially manufactured dryer capable of loading a ton of fish. The solar dome is manufactured by Clovis Lande, England, and its dimensions are 4.26 m wide, 2.0 m high and 7.6 m long. The experiments performed have shown favourable results in improving quality and reducing losses, though several factors need to be taken into account in the use of commercial solar dryers.

It is worthy to note that if solar dryers are to be used in developing countries, like the Gambia, to improve drying technology, it should not be done in isolation from other factors which contribute to losses and also need to be improved. Better salting methods, improved fermenting techniques, better packaging and storage methods are all areas to be investigated and developed to avoid problems that can cloud the advantages of solar dryers, and possibly defeat the purpose of the project.

The socio-economic factors governing the activities in cured fish production and the responses to technology transfer are key issues to be considered when introducing solar dryers.

This report attempts to deal with all these points and focuses centrally on aspects of losses due to fermentation of fish prior to drying, which is a stage inherent in the traditional drying process. Other factors related to fish drying in the Gambia have also been looked into, and a summary of the Traditional Codes of Practice is provided in Appendix 1.

1. INTRODUCTION

The main problem that prompted research in the use of solar dryers for fish-drying is the extent to which losses are encountered.

Fish-drying is an aged-old traditional practice done in the Gambia both by nationals and foreigners. Salting and drying are mostly used in conjunction with each other and fish is spread on the ground, on wooden racks or on rocks. In an attempt to alleviate some of the problems associated with losses due to the methods used, solar-drying has been launched to assist with the achievement of the Government's development priorities aimed at increasing food production, especially protein-food supplements. Fish fermenting is an integral part of the traditional processing method, and without such, the dried product will not suit consumer acceptance and may be difficult to market.

The trade in and production of dried fish and fishery products has many economic advantages. In 1983, about 500 t of cured fish were recorded as having been exported to neighbouring countries and Asia. Large amounts are sold and consumed locally and much leaves the country unrecorded.

Catch Assessment Survey 1983 of the Fisheries Department has indicated that a total of 8 455.5 t of artisanal catches were landed, and of this, 1 952.2 t were demersal fish. From this 1 952.2 t all the cassava fish (Otolithus brachygnathus), sharks and rays were assumed to have been dried-salted. Total estimated weight of cassava fish landed was 296.1 t and for sharks and rays 376.9 t. Cassava fish, sharks and rays are always sun-dried. From the balance of 1 656.1 t of the demersal catch, comprising generally groupers, croakers, grunts, threadfins, etc., it would be estimated that at least 45%-50% was dried-salted; 765.5 t of catfish was recorded and since only a small amount of this fish is smoked and sold in local markets, it may be logical to assume that at least 70% was sun-dried. Catfish is commonly smoke-cooked partially by women in small quantities and sold for local consumption, predominantly in urban and semi-urban areas. Sea-snails are dried all year round but data on the amount is difficult to obtain.

It can, therefore, be seen that an organized commercial drying network, employing improved methods and facilities, would be economic, especially with increasing demand for fish-foods throughout the country and in the sub-region.

2. MATERIALS AND METHODS

2.1 Materials

(a) Commercial solar dome with metal hoops, frames, beams and hooks. Concrete floor painted black;

(b) plastic containers, knives, cutlasses, seawater, fish, sea-snails and salt;

(c) balance, pedestal spring metric 5 kg;

(d) balance, Salter (oval) - 25 kg

(e) balance, moisture metre Ohaus 5 100 HE

2.2 Methods

2.2.1 Method 1 - 30/7/84

(a) All the bonga (E. frimbriata) from a canoe was bought around 4.30 p.m., at Tanji Village about 5 km from the experimental centre. The whole batch used consisted of about 3 000 fish; total weight estimated at 750 kg as each fish weighed about 200-300 g;

(b) the bonga was unloaded from the canoe by women putting them in metal containers capable of taking 200-250 fish and transferring them to the vehicle;

(c) 50% brine solution was prepared using local salt and well water, density being measuring with a hydrometer;

(d) all the fish were immersed in the brine solution in plastic containers and left overnight (about 16 hours) to ferment. They were then descaled, gutted, washed, salted and dried. Gills were also removed;

(e) the dryer was loaded with fish in hooks in the beams lying on the frames and the number of fish counted. The remainder of the batch were salted and spread on racks of various designs in the yard and allowed to dry in the sun;

(f) after fermenting in 50% brine and descaling, gutting, etc., the amount of fish discarded due to disintegration of their soft putrid flesh was also recorded;

(g) salting was done by filling the gut cavity of the fish and then sprinkling salt all over it;

(h) ambient temperature and humidity was recorded using a sling hydrometer;

(i) fish left to sun dry were covered with clear polythene sheet every evening at sunset. During drying these were turned from time to time;

(j) the air vents of the dryer were shut every evening around 5.00 p.m.

2.2.2 General observations

(a) After fermenting by leaving in 50% brine overnight, all the fish had the following appearance: dull, bleached skin; soft texture; sunken eyes with grey pupils and discoloured cornea; bleached gills brownish in colour; and definite odours of sulphides and amines;

(b) some of the fish had developed very soft texture; they were almost disintegrating and difficult to descale and clean. All the fish with disintegrated flesh were discarded and recorded. Those damaged due to rough handling while preparing the fish were also discarded and recorded under the same column;

(c) blowflies were abundant. Drying lasted three days. Many of the sun-dried fish were discarded before the end of three days drying due to excessive maggot infestation. Only a few were discarded from the solar-dried fish;

(d) the solar-dried fish were dust-free and had a better appearance.

2.2.3 Method 2 - 7/8/84

(a) Canoe load of bonga (E. frimbriata) purchased at Tanji around 4.30-5.00 p.m.;

(b) the batch used consisted of 3 025 fish, and all were fermented;

(c) fermentation was done in concrete tanks filled with seawater and left overnight for approximately 16 hours;

(d) method follows as in Method 1, 2.2.1.

2.2.4 General observations

(a) All fish had putrid characteristics with bulging abdomen and bleached skin, etc.;

(b) amount discarded after fermenting was greater than that obtained for Method 1;

(c) soft texture, delicate to handle when descaling and gutting fish.

2.2.5 Method 3 - 14/8/84

(a) About 1/2 a canoe-load of bonga and mixed species of spoilt and fresh demersal and pelagic fish were bought and sorted into small batches according to species;

(b) these small batches were placed in separate compartments of the concrete tank, filled with sea-water and left to ferment overnight for 16 hours approximately;

(c) fish were then removed, descaled, gutted, washed, salted and dried (sun-dried/solar-dried), as described in Method 1, 2.2.1;

(d) drying lasted for about four days;

(e) bonga was salted by filling the gut cavity and then sprinkling salt over the fish. Other species were split to backbone, guts and gills removed, and sometimes head. About a handful of salt was sprinkled over the fish. Most of those used for solar drying were large pieces which were placed on trays and not hooked as for the bonga.

2.2.6 General observations

(a) White fleshed fish developed a soft texture, which was tougher than that of the bonga. Descaling was easier as these species have thicker skins. Gutting was also easier as fish were split open, whereas with bonga the guts were removed by placing a finger in the fish cavity and pulling them out;

(b) discards after fermenting all the fish were observed to be greater with the bonga than with the whitefishes. The latter had soft texture and because of their sizes and geometry they were not dried on hooks but laid on trays. Mackerel had a texture that was extremely soft and difficult to prepare;

(c) after sun and solar drying, respectively, the mackerel were very brittle. Most of them disintegrated and were discarded;

(d) very few maggots were found in the split whitefish in the solar dryer and practically none in the bonga. Sun-dried fish especially the split whitefish were invaded by maggots. Some of the bonga also had maggots especially in the gut cavities;

(e) rain with strong winds for about two hours, but subsided and the sun came out later.

2.2.7 Method 4 - 21/8/84

(a) Mixed species, as described in Method 3, were bought; bonga predominated in the batch;

(b) fish were placed in separate compartments of the concrete tank and filled with sea-water. A basket of local salt (5 kg) was added to the sea-water in the tanks. The fish immersed in sea-water was left to ferment overnight;

(c) gutting, descaling, washing, salting and drying (sun-drying and solar-drying);

(d) method follows as explained earlier.

2.2.8 General observations

(a) General observations similar to those of Method 3. Addition of salt in sea-water and fermenting did not make much difference. Probably amount of salt used was not enough.

2.2.9 Method 5 - 3/9/84

(a) Mixed species of fish bought (i.e., bonga, croakers, grunt, mackerel and cranx);

(b) separated in smaller batches. Some placed in concrete tanks, others in plastic buckets;

(c) fish left exposed at ambient temperature for about 16 hours. No sea-water or brine;

(d) descaled, gutted, washed, salted and dried (sun-dried and solar-dried).

2.2.10 General observations

(a) Fish were very difficult to prepare especially due to very putrid odours and soft texture;

(b) flesh of mackerel already disintegrating into pieces during gutting and cleaning. Most disintegrated during packing after drying;

(c) more discards were recorded than with other methods.

3. GENERAL METHODOLOGY

(a) Landed bonga is commonly unloaded from the canoes by women using almost uniform, metal containers (pans). These pans can take 250-260 (± 20) fish which weighed between 210 and 280 g. Average weight taken as 250 g;

TABLES OF RESULTS

Method 1. Fermenting in 50% brine in plastic containers (fish heavily salted)

Species	Estimated number of fish	Estimated weight	Number discarded after	Discards after fermenting	Number solar-dried	Number sun-dried	Number discarded after solar-drying	Number discarded after sun-drying	Total discards (estimated)
Bonga	3 000	750 kg	200 ≅ 50 kg	6.7%	1 600	1 200	620	7	827

Ambient humidity = 72%

Ambient temperature = 30°C

Method 2. Fermenting in sea-water in concrete tanks (fish lightly salted)

Species	Estimated number of fish	Estimated weight	Number discarded after	Discards after fermenting	Number solar-dried	Number sun-dried	Number discarded after solar-drying	Number discarded after sun-drying	Total discards (estimated)
Bonga	2 087	521.75 kg	320 ≃ 80 kg	15.3%	1 200	567	345	10	675

Humidity = 77%

T^oC = 32°C

Method 3. Fermenting mixed species in sea-water in concrete tanks (moderately salted)

Species	Estimated number of fish	Estimated weight	Number discarded after fermenting	Discards after fermenting	Number solar-dried	Number sun-dried	Number discarded after solar-drying	Number discarded after sun-drying	Estimated total discards
Bonga	2 500	≅ 625 kg	297	11.9%	1 105	1 098	–	112	409
Caranx sp. (Fetta, Sacca)	100	≅ 70 kg	–	–	65	35	–	3	3
Mackerel	77	≅ 144 kg	11	14.3%	40	26	3[a]	8[a]	22
Croaker (Cassava fish)	14	≅ 42 kg	–	–	–	9	no discards re-drying due to maggots	5	–
Grunts (Sompat)	8	≅ 16 kg	–	–	–	4	"	4	–

Humidity = 71%

$T^{o}C = 28^{o}C$

[a] Discard during storage. Flesh disintegration due to brittle texture

Method 4. Fermenting mixed species in sea-water with salt added in concrete tanks (moderately salted)

Species	Estimated number of fish	Estimated weight	Number discarded after fermenting	Discards after fermenting	Number solar-dried	Number sun-dried	Number discarded after solar-drying	Number discarded after sun-drying	Estimated total discards
Bonga	1 655	≅ 413.75 kg	199	12%	825	631	4	68	271
Caranx sp.	212	≅ 148 kg	3	1.4%	110	99	–	9	12
Mackerel	30	≅ 75 kg	4	13%	21	15	7[a]	5[a]	–
Croaker	–	–	–	–	–	–	–	–	–
Grunts	–	–	–	–	–	–	–	–	–

Humidity = 72%

T°C = 31°C

[a] As in Method 3

Method 5. Fermenting in concrete tanks and plastic buckets (only by leaving overnight)

Species	Estimated number of fish	Estimated weight	Number discarded after fermenting	Discards after fermenting	Number solar-dried	Number sun-dried	Number discarded after solar-drying	Number discarded after sun-drying	Estimated total discards
Bonga	1 500	375 kg	251	16.7%	940	309	10	93	354
Caranx sp.	158	41 kg	18	11.4%	95	45	-	re-drying due to maggots, beetles	18
Mackerel	16	32 kg	5	31.3%	7	4	3[a]	4[a]	12
Croaker	-	-	-	-	-	-	-	-	-
Grunt	18	36 kg	4	22.2%	9	5	-	re-drying due to maggots, beetles	-

Control heavy salting

[a] Brittle and break easily after drying

(b) other species used in the trials were also weighed:

mackerel average estimated weight = 2.0 kg
cranx " " " = 700 g
croaker " " " = 3 kg
grunt " " " = 2 kg

(c) representative samples were selected from each pan of bonga and each fish in the samples weighed. For the bonga the number of pans obtained was always recorded. After loading the solar dryer and spreading on racks, the fish were again counted. Other species were also measured;

(d) discards were selected by examining the degree of maggot and beetle infestation in fish during and after drying, and recommending such. Storage problems were encountered as the roof of the store was leaking, and due to this, dried fish still with relatively few maggots after the drying period were discarded. The number of individuals discarded was recorded;

(e) discards resulting from fermenting were placed in polyurethane fish boxes and recorded. These were recommended when fish muscles disintegrated completely or were damaged while being prepared for salting and drying.

4. DISCUSSION

Fermenting fish is as old as the traditional process of sun-drying fish in the Gambia. In fact, it is an inherent stage of the local technology which gives the end-product a rather sour taste when dried to suit consumers.

However, due to the very crude ways in which fish fermenting is done locally, it is assumed that its contribution to post-harvest losses during dried fish production is significant.

The term "fermenting" is used broadly to mean a process in which biochemical changes are brought about in an organic substrate through the action of enzymes elaborated by micro-organisms. This process is aided by increased temperature and under favourable conditions putrefaction will occur rapidly. Traditionally, fish to be dried is usually left in containers or under a shade in hot seasons to spoil by the next day. In cold seasons the fish for sun-drying with guts and gills in are placed in holes in the soil in a cool area and left overnight to ferment. It is clear that these actions are done to aid proteolytic changes and bacterial invasion with leads to softening of the tissues of the fish and very unpleasant odours. This situation poses many difficulties in preventing losses and as the fermented fish are very difficult to prepare, some losses are again encountered when handling and cleaning and preparing for drying.

The use of solar dryers for fish is known to have a wide perspective, especially in reducing losses and improving quality, and in some cases, reducing drying time. Nonetheless, if solar dryers, especially commercial solar dryers are to be introduced for use in developing countries, like the Gambia, it should not be done in isolation from other factors which contribute to losses and which also need to be improved. As fermenting is a stage in the local drying process not to be omitted if the products are for local markets and consumption, this aspect needs to be investigated and improved. Better packaging and storage methods are also important areas needing improvement.

In an attempt to do this, the trials carried out in this report have shown that sea-water is effective and appropriate. Losses encountered at the end of the fermenting process, and during descaling and gutting fish were reasonably low; and given the location of the drying yard, the use of sea-water proved expedient. Fermenting in brine showed far better results but this cannot be encouraged as yet, because fresh water is practically unavailable on site. The water obtained for the brining trials was from a well about 10 m from the drying yard and is used by all in the fishing area.

The use of commercial solar dryers should be particularly directed toward loss reduction and increased production. Taking into account the view of the local processors who rely on sun-drying, investing in the new technique would seem a folly because even with a well-dried and cleaner product the price remains the same or almost the same as for those prepared traditionally. Consequently, it is crucial that local processors be organized and educated to be "loss-oriented", and be shown how heavy losses, due to sun-drying hazards, can be alleviated by the use of solar dryers.

In terms of organization, it was imperative from the onset of this project to include local women in the activities of drying and maintaining the drying yard. These women were to assist in the work during the trials and, with the exposure and insight, to continue operating after the experimentations as an "association" strictly on a commercial basis. There has been significant progress, and with the assistance of a loan from the Department's revolving loan scheme, there are good prospects of them making full use of the facilities and expanding profitably. It is realized that in using the solar dryer, large quantities of fish can be dried with very little losses, or none sometimes; and that with improved fermenting techniques, in general, more finished products and less discards will be available per batch of dried fish. Disregarding costs and other constraints, fermenting in 50-60% brine, or in melting ice may be more appropriate and effective.

Among the pertinent considerations in technology transfer of this kind is the nature of the fish processing sub-sector, and the socio-economic links within the entire artisanal sector.

Fisheries Department Frame Survey 1983 has recorded 241 Senegalese and 397 Gambian fishermen operating along the Atlantic coast. This gives a clear indication of the reciprocal involvement of Senegalese nationals in the processing sub-sector, particularly in drying. This aspect is important in considering the amount of fish that may be available for solar drying and how the distribution of that amount occurs. In the Lower River, 560 Gambian and 180 Senegalese fishermen were recorded, but it has been observed that fishing effort in this area is low and drying is not as intensive and structured as in the Atlantic coast.

To operate a large-size dryer as that used in this project, it will be prudent to organize the local processors into an "association", operating in a yard provided with a shade, gutting platforms, tanks for fermenting, a store and other facilities. Preparing fish for loading inside the dryer is quite burdensome, and fermenting large amounts of fish by leaving them on the ground overnight is unsanitory and wasteful. Usually all the fish at the bottom are discarded. Additionally, if the dryer is to be commercially viable it should be fully loaded with all available species.

Demersal fish are less available but fetch good profits when dried. Pelagic fish is abundant but provides little profit when dried. Sharks and rays are more liked by Ghanians and are usually landed as by-catch. Accordingly, this report suggests that for full commercial utilization of a fish solar dryer loading 1 t per batch, drying of assorted species will be essential. As dried fish sold on a wholesale basis are preferably dried to about 40% moisture content (wwb) to give the product more weight and monetary benefits, it is important for local processors to know the problems of losses associated with such products during storage.

It is a generally accepted view that the introduction of any new technology in developing countries is usually met with problems and constraints that are fundamentally socio-economic. This report, however, concedes that despite all these problems the use of commercial solar dryers for fish could be a vital factor in the development of our traditional fish technology. Solar dryers produce good quality, dust-free products; prevent blowflies from attacking fish and are useful during the rains.

The solar dome was found adaptable to the local community and it has shown considerable promise for use in dried-fish production. Its impact on the sub-sector has been evident in that women nationals have been organized and engaged in intensive drying using the facility on a strict commercial basis and with the assistance of the Department in the provision of transport; the "association" has been realizing profits. Extensive and sensitive use of solar drying could also improve fish distribution and food supplies. More dried fish could be taken up-country and if storage facilities are adequate large amounts can be stored while awaiting transport.

5. CONCLUSIONS

The use of commercial solar dryers for fish has important advantages in the development of traditional processing technology in the Gambia.

Solar dryers produce well-dried products of good quality with long storage life. They reduce losses from blowfly infestation and maggots to insignificant proportions. Therefore, the introduction of commercial dryers should be particularly directed toward preventing losses.

Other aspects which also contribute to losses should be investigated and improved. One such aspect is the fermenting process which is inherent in the traditional technology; its crudity causes losses due to tissue disintegration.

To avoid clouding the advantages of solar drying it is crucial to improve post-production system, such as packaging and storage to contain the proliferation of beetles (*Dermestes* sp. and *Necrobia* sp.) in the dried fish and so prevent heavy losses.

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APPENDIX 1

Traditional Practices for Cured Fish and Fishery Products

The information provided in this appendix has been obtained from a survey carried out along the Atlantic coast in all the fishing sites. Questionnaires were used.

Though drying is carried out all year-round on wooden racks or on the ground in the sun, there are slight variations in the techniques used for each season. The methods of smoking are the same for bonga and other species, except catfish which is normally smoked differently and on a relatively small-scale.

During the survey, between five and ten individuals from each processing site were interviewed. The survey was conducted in two seasons (i.e., wet and dry seasons) in 1983 (i.e., March/April - July/August) to ascertain whether there are differences in the techniques used at different climatic conditions.

DRYING OF WHITE FISHES (Demersal species)

Sun-drying is the normal practice and fish are spread on low wooden racks, on the ground or roof-tops or on rocks.

Demersal species commonly dried are croakers, groupers, threadfins, grunts, etc. As these fish have a high value when fresh they are sun-dried only when landed spoilt or stale.

Whether fresh or stale the fish are fermented overnight by wrapping in bags or leaving in containers during the hot season. In the cold season the fish is placed in holes in the ground and covered with jute bags or plastic and left till the next day.

Fish are descaled, gutted and split and the gills removed. Usually the heads are cut off and large fish are cut into smaller pieces.

Salting is done simply by sprinkling local salt granules over the fish and drying in the sun. Heavy salting is applied during the rainy season and light salting in the dry season.

Drying takes about three-four days during the dry season and four-five days during the wet season. When sun-drying during the rains, fish are covered with plastic sheets. Re-drying fish is common as storage facilities are inappropriate and beetle infestation prevalent.

PACKAGING AND STORAGE

Dried fish are packaged in locally-made baskets, wooden boxes or jute bags. However, packaging is done usually at a time when fish is to be transported and not during storage. While in store, fish normally have to be re-dried from time to time and left on the ground. Sometimes in the dry season the dried fish are packed in heaps on racks and covered with black PVC or clear polythene at sunset.

Traditionally, pelagic fish such as shads, catfish and mullets are also fermented and dried-salted.

Shads (e.g., bonga) and mullets are gutted by pulling the intestines and stomach out after removing the gills, whereas catfish have their heads removed and the flesh sliced open.

Mackerel and Caranx spp. are also sun-dried usually whole with only the heads off. Flesh is split to backbone and the fish are spread in the sun.

Salting of shads and mullets is done by putting salt in the gut cavities and then sprinkling salt over the flesh of fish. Catfish, mackerel and Caranx spp. are sprinkled with salt over their opened flesh.

Drying takes three-four days, and four-five days in wet seasons.

Sharks and rays are not commonly fermented prior to drying. They are obtained fresh, gutted and split open. Sometimes the large ones are cut traversely into pieces, washed, salted and dried. Salt is applied only in the split cavity.

Drying last four-five days during the rains and five-six days in the dry season. They are stacked on the platforms always left in the sun. During the rains they are covered with polythene. Sometimes they are lightly smoked after drying to prevent infestation by beetles.

Packaging is done only for transport, as explained previously.

- Sea snails (whelks) are dried in large amounts annually but are usually obtained from the trawl by-catch at sea from fishing vessels. Sometimes they are also available from the by-catch of artisanal landings.

During the hot season, snails with shells on are kept overnight, then the shells are crushed, the stomach removed, and the flesh sliced and left to dry in the sun.

During the cool season the snails with shell on are buried in holes and covered with jute bags or plastic overnight. This ferments the flesh which is easily removed the next day, washed, sliced and dried.

Sea-snails are not salted and but are not attacked by blow-flies.

SMOKING

Bonga is the fish commonly smoked and in large quantities. They are not gutted, gilled, salted or washed.

The landed fish is unloaded in pans by women and taken straight into the smoke-huts.

Smoke-huts are equipped with two large, long metal racks, low to the ground and capable of loading about a ton each.

Smoking is done in five firings in five days. Fish are placed belly-down on the first firing when temperatures may be as high as 117°C. As the racks are low to the ground and close to the fire some of the fish in the bottom layer becomes cooked. Smoking continues the whole day for about six-ten hours.

The second firing is done with an intense heat with the fish turned belly-up and smoked dorsally for about six-ten hours.

The fire is less intense in the third firing and fish are smoked ventrally for about five hours.

On the fourth firing fish are placed dorsally and smoked with a low fire.

During the fifth firing the heat is held very low and the whole batch on the rack is stacked belly-down and high-up and heated for about five hours.

Packaging is done by packing about 45-50 kg of the smoked bonga in wooden crates or in baskets.

Packed smoked fish are then stored in the smoke-hut on the sides.

CATFISH SMOKING

In catfish smoking the product is partially cooked.

Fish is washed to remove slime, gutted and gills removed. Smoking is done by burning wood in half metal drums until a glowing charcoal is left in the fire pit.

The fish are then placed over the fire on grills and covered with wet jute bags.

The jute bags are kept wet by sprinkling water over them from time to time to lower the temperature in contact with the fish.

The smoke drums are such that there is a grill on top and a fire pit at the bottom and no other ventilation.

Smoked catfish are usually not stored for long durations. They are sold in local markets, mainly in urban and semi-urban areas. If they are to be stored, re-smoking is done occasionally.

ETUDE DE LA TECHNOLOGIE DESTINEE A L'AMELIORATION DU TRAITEMENT ARTISANAL DU POISSON: CAS DES ATELIERS DE SECHAGE SOLAIRE

par

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RESUME

La présente étude porte sur les possibilités de développement technologiques du secteur de traitement artisanal du poisson, et sur son amélioration dans le cadre de la modernisation des activités halieutiques artisanales.

L'idée d'implanter des ateliers de séchage solaire dans les centres de pêche répond au souci d'apporter des solutions technologiques conformes aux besoins des transformatrices et capables de mieux valoriser les ressources halieutiques locales.

1. INTRODUCTION: ANALYSE TECHNIQUE ET SOCIO-ECONOMIQUE DE LA TRANSFORMATION ARTISANALE DU POISSON

1.1 Caractéristiques générales du secteur

La transformation artisanale constitue une activité importante pour la plupart des femmes vivant autour des centres de pêche. Leur nombre ne cesse d'augmenter car la sécheresse persistante libère paysans et paysannes qui s'adonnent alors aux diverses activités de la pêche artisanale pour survivre.

Ce secteur procure des milliers d'emplois et d'importants revenus; la transformatrice devient un véritable entrepreneur, utilisant au minimum les services de 3 à 5 personnes pour se ravitailler en matière première, effectuer le prétraîtement du poisson frais, surveiller les opérations de séchage[2], conditionner et emballer les produits finis et commercialiser la production.

Les conditions de préparation et de stockage du poisson transformé sont généralement loin d'être idéales. Par exemple, la matière première est débarquée à n'importe quelle heure de la journée ou de la nuit[3], le travail se fait à mains nues, souvent à terre, avec un matériel sommaire. Les instruments de production, de stockage ou de conditionnement sont entassés ou éparpillés autour des claies de séchage et ne sont guère entretenus.

Les mauvaises conditions d'hygiène des centres de traitement sont aggravées par la pollution environnante: une multitude de mouches infeste les poissons en traitement, ils sont attaqués par des larves et adultes de dermestes, de nécrobies et par des rats les déchets de traitement, et ordures de toute sorte jonchent le sol, l'électricité et l'eau courante sont pratiquement inexistantes. Les eaux usées sont rejetées à même le sol. La méconnaissance ou le non respect des conditions élémentaires d'hygiène et de propreté porte atteinte à la qualité des produits finis. Les transformatrices utilisent une série d'insecticides (DDT ou PROPUXUR mélangé au sel) pour préserver la production dont le temps de conservation ne dépasse guère 2 à 3 mois pour le kéthiakh, le guedj et le tambadiang et 6 à 8 mois pour le métorah et le sali (cf. annexe 1).

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[1] Chercheur technologie conservation et traitement des produits de la pêche

[2] Au Sénégal, le fumage reste du ressort des hommes guinéens ou maliens

[3] L'approvisionnement des transformatrices en matière première est irrégulier dans le temps et l'espace, et ce d'autant que les structures de conservation du poisson frais n'existent pas

La commercialisation du poisson transformé pose des problèmes aigus aux transformatrices alors que la demande au niveau local ou africain excède l'offre. Les mareyeurs fixent les conditions de vente en jouant sur la fragilité du marché, la concurrence très forte, les limites financières des productrices[1], et les impératifs d'écoulement des produits relatifs aux habitudes des consommateurs locaux.

Seule la solution à ces différents problèmes d'ordre technique, social et économique peut permettre un développement continu, rationnel et complet du secteur du traitement artisanal du poisson.

1.2 Tendances de développement du secteur

De la même façon que le développement de la pêche artisanale, la transformation est passée de la production pour l'usage à la production pour l'échange[2]. Cependant, le séchage naturel du poisson qui concerne 80 % des quantités traitées artisanalement, connaît une certaine stagnation depuis 1960 à la suite de l'application du décret gouvernemental interdisant le séchage au sol, au profit du séchage amélioré par l'emploi de claies, sur les plages de débarquement.

Les deux tentatives principales d'amélioration de la production de poisson séché ont eu lieu, sans succès d'ailleurs à Saint Louis et à MBour à vingt ans d'intervalle. L'arrêt de l'alimentation en eau du centre de Saint-Louis est la raison principale de cet abandon par les transformatrices. Les femmes de MBour, non consultées lors de l'élaboration du centre de MBalling refusent de se déplacer et aucune issue à ce conflit n'est en vue depuis trois ans. Quant au mouvement coopératif des transformatrices, son fonctionnement est bloqué par deux difficultés majeures: l'émergence d'un esprit coopératif réel, la lenteur et le blocage des processus administratifs.

Toutes les opérations de développement des moyens de traitement dans les centres de pêche par l'implantation d'usines privées se sont soldées par des échecs qui traduisent la mauvaise utilisation de ressources rares - capital et énergie - dans des localités riches en espèces halieutiques très recherchées sur les marchés extérieurs. Ceci montre que la réussite d'un projet à technologie centralisée ou décentralisée est également conditionnée par l'accord et la participation financière des intéressés, pêcheurs et transformatrices.

Enfin, le bilan global de la recherche appliquée pour la technologie du poisson est relativement maigre. Tous les projets ont porté et portent encore sur une technique de traitement au détriment d'une étude globale des améliorations nécessaires au secteur.

1.3 Résultats des recherches sur l'adaptation d'un séchoir (dessiccateur) solaire au séchage artisanal du poisson[3]

L'expérimentation des différents prototypes (cf. annexe 2) menée à l'Institut de technologie alimentaire ont permis d'apprécier les améliorations apportées par le séchoir solaire par rapport au séchage naturel du poisson et de choisir la forme et le type du prototype adapté aux conditions locales de traitement du poisson. Finalement, deux prototypes ont été retenus pour expérimentation dans les centres de pêche.

1.3.1 Essai des 2 prototypes en milieu local

(a) Caractéristiques générales du séchage solaire du poisson

Le mode de séchage pratiqué est le séchage statique. Le séchage du poisson suspendu permet de doubler la capacité de traitement mais ne convient guère qu'au poisson salé dont la chair est ferme[4]. En outre, l'emploi de claies de séchage à double étage permet de doubler la capacité de séchage statique.

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[1] Les transformatrices ne bénéficient ni de crédits bancaires, ni de moyens de transport pour écouler leur production

[2] Cf DURAND (M.H.): 1981: Aspects socio-économiques de la transformation artisanale du poisson de mer - Arch. CRODT/ISRA

[3] Le programme d'amélioration du séchage artisanal, débuté à la demande de la FAO après le passage du Professeur Doe est mené avec l'aide d'un financement USAID/ITA

[4] Il est impossible de sécher sans dommages du poisson fermenté ou braisé suspendu

Les avantages d'un dessiccateur sur le séchoir traditionnel peuvent se résumer ainsi:

- économie de temps pour l'opérateur avec un rendement de production dépassant 0,650 kg/h/m^2 quelles que soient les espèces utilisées;
- réduction notable de l'influence des variations climatiques: poussières, pluie, humidité nocturne;
- élimination des pertes dues à l'infestation du poisson en cours de séchage (dermestes, nécrobies et rats) sans usage d'insecticide;
- poisson séché de meilleure qualité chimique, microbiologique et organoleptique.

(b) Technologie de séchage solaire du poisson prétraité.

- Le guédj: après fermentation du poisson, un préséchage solaire naturel de 4 à 5 heures avec ouverture de la porte d'accès est nécessaire pour éviter la formation d'une croûte à la surface du poisson (températures de préséchage inférieures à 42°C et bonnes conditions de ventilation). La phase effective de séchage solaire accélérée dure de 25 à 27 heures pour le silure fermenté, de 21 à 23 heures pour le capitaine fermenté et de 17 à 20 heures pour le requin fermenté en morceaux (taux d'humidité inférieures à 27 %). Le séchage du poisson fermenté en morceaux ou en couche fine est très rapide et plus facile. Les températures de séchage solaire accéléré ne doivent pas dépasser 46°C pour éviter l'altération de la couleur et la saveur du produit final.
- Le kéthiakh: le braisage abaissant la teneur en humidité à moins de 68 pour cent correspond à la phase de préséchage; la phase effective de séchage solaire dure environ 18 heures et le kéthiakh obtenu a une chair consistante, très appréciée, et présente un bel aspect avec une teneur en humidité inférieure à 25 %.
- Le saly: après salage et égouttage correct, la phase effective de séchage solaire du poisson salé dure de 20 à 25 heures selon l'espèce et la taille.
- Le tambadiang: après égouttage correct du poisson entier mi-fermenté et salé à sec, suivi d'un préséchage solaire naturel de 4 à 5 heures, le séchage solaire du tambadiang est très rapide avec les espèces maigres de taille petite ou moyenne pour les raisons suivantes:
- l'eau diffuse rapidement du centre du poisson vers la surface si cette distance est courte;
- une teneur élevée en matières grasses dans la chair représente une barrière à la diffusion et ralentit le séchage.

1.4 Conclusion

Cette phase de recherche sur l'adaptation du dessiccateur solaire aux conditions locales de traitement[1] a permis de préciser à la fois:

- ses performances, que résume ainsi un expert d'évaluation technique du projet: le dessiccateur solaire accélère le processus de séchage sans recours aux sources conventionnelles d'énergie, permet d'obtenir un degré d'hygrométrie uniforme et règle le problème de l'infestation par les insectes;
- ses limites, comme le laisse entendre la phrase suivante d'une sociologue sénégalaise[2]: "Le séchoir solaire résout seulement un problème technologique en portant la qualité de la production artisanale au niveau des normes internationales, maintenant il faut l'intégrer au problème global de l'économie du poisson séché: conditionnement et stockage du poisson frais, achat et financement du matériel de production, aide à la commercialisation et à l'exportation." Le coût de construction du dessiccateur (FCFA 50 000 au minimum) et les feuilles de polyéthylène à remplacer au bout d'une année, représentent les principales critiques des transformatrices à l'égard du nouvel outil.

Que faire? Répondre à la question suivante au cours de la phase de prévulgarisation: le dessiccateur solaire peut-il constituer une méthode de conservation économique pour les productrices et les consommateurs locaux, sachant que les conditions favorables au séchage naturel ont engendré une absence de productivité.

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[1] Cette phase de recherche menée avec des transformatrices très averties des problèmes du milieu, n'a pas nécessité de préparation ni de sensibilisation particulière de ces femmes

[2] Cf. Fatou SOW, novembre 1983; l'économie du poisson sur la Petite Côte: le rôle des femmes CNRS/IFAN-DAKAR

2. MATERIELS ET METHODES

2.1 Matériels

Quatre ateliers de prévulgarisation du dessiccateur solaire ont été construits à MBour, Joal, Kayar et Missirah entre novembre 1983 et février 1984; chaque atelier (cf. figure 1) est composé de 2 dessiccateurs solaires (cf. figure 2), de 2 à 3 fours de braisage et de fumage, des cuves de fermentation, lavage et salage, une claie d'égouttage (cf. figure 3), un abri pour la préparation du poisson frais, un hangar de stockage des produits transformés et éventuellement un puits.

2.2 Méthodes

2.2.1 Organisation des travaux d'exploitation des ateliers

Un technicien de l'Institut de technologie alimentaire est responsable de chaque atelier qui dispose d'un encadrement technique local de 2 agents des Pêches de la localité pour assister l'équipe de transformatrices en activité et recueillir les enquêtes socioéconomiques.

Les transformatrices intéressées par l'atelier sont recensées et divisées en groupes de six personnes se relayant à un rythme déterminé. Chaque équipe élit un conseil de gestion (2 à 3 personnes) qui détient le fonds de roulement (FCFA 100 000) pour l'achat de matières premières, le paiement de la main-d'oeuvre temporaire et gère l'écoulement de la production. La somme utilisée pour chaque production est restituée au fonds de roulement après vente des produits finis.

2.2.2 Formation des transformatrices aux techniques améliorées, dans les ateliers

Les agents de la division "poissons" de l'Institut de Technologie alimentaire, assurent la formation des transformatrices de chaque équipe d'atelier aux techniques améliorées de:

- prétraitement du poisson frais: braisage, fermentation, salage, fumage;
- séchage solaire du poisson prétraité;
- conservation du poisson séché.

En outre, l'intervention des agents a porté sur la nécessité de travailler avec de la matière première de qualité et de respecter de bonnes conditions d'hygiène tout au long de la chaîne de traitement du poisson séché.

3. RESULTATS ET DISCUSSIONS

3.1 Conditions d'exploitation

3.1.1 Capacités de traitement des ateliers

La capacité des structures de prétraitement se présente ainsi:

- 500 kg de poisson frais par cuve de fermentation, lavage et salage;
- 600 à 700 kg de sardinelles et d'ethmaloses par four de braisage (à chaque fournée de 3 heures) selon la longueur du fumoir, la taille et la disposition des espèces;
- 600 à 750 kg de silures et de capitaines par four (2 feux) avant séchage solaire.

La capacité de séchage d'un atelier varie d'environ une tonne avec des claies à une seule couche de séchage, à deux tonnes en moyenne avec des claies à double étage ou à deux couches superposées1/. La durée de séchage varie de 24 à 48 heures selon les transformatrices et les besoins des mareyeurs qui répugnent à commercialiser du poisson séché contenant moins de 30 % d'eau. Les artisanes estiment en effet, que du poisson séché pendant une journée dans le dessiccateur solaire est prêt à la commercialisation le lendemain vers 11.00 h du matin.

1/ La capacité de séchage du déssiccateur est en fonction de la taille et de la nature du prétraitement du poisson frais

3.1.2 Intéressement des transformatrices aux ateliers

Les ateliers de séchage solaire ont particulièrement intéressé les artisanes des différents centres de traitement. Le recensement des transformatrices demandant à y travailler après un mois d'exercice se présentait ainsi: 300 femmes à MBour, 70 à Joal, 70 à Kayar et 120 à Missirah. En outre, les responsables des coopératives locales de traitement assistent les comités de gestion pour l'acquisition de poissons frais auprès des pêcheurs.

3.2 Résultats d'exploitation

3.2.1 Résultats d'ordre général

- La conception de l'atelier permet de fabriquer tous les types de poissons séchés au Sénégal selon la disponibilité des matières premières et la demande des clients, et ce malgré la spécialisation antérieure des transformatrices sur un seul produit[1]. Ainsi, les transformatrices affirment être en mesure de produire toute l'année de façon continue, quelles que soient les espèces débarquées;

- Les transformatrices ont assimilé rapidement les innovations technologiques introduites dans les ateliers. Celles-ci se sont traduites par une économie du temps de séchage (1 à 2 jours selon la taille des espèces et le désir des mareyeurs) et du combustible de braisage des sardinelles et des ethmaloses (30 % environ par rapport au braisage traditionnel);

- Les structures de prétraitement et de séchage solaire au sein des ateliers se sont traduites par une rationalisation de la technologie de fabrication des différents types de poissons séchés (Cf. tableaux 1, 2, 3, 4).

3.2.2 Analyse des coûts de production

- Quel que soit le type de poisson séché, les dépenses totales de fabrication couvrent l'achat de matières premières (représentant 68 à 82 % des sommes dépensées) et les frais généraux. Les pourcentages valeurs-matières-frais généraux varient selon les différents produits séchés et les centres de pêche (Cf. tableaux de 1 à 5);

- Les prix d'achat de la matière première à partir du centre de pêche, ou venant de l'extérieur passent du simple au double selon les fluctuations du marché (offre-demande);

- Les frais généraux fixés par panier selon le centre de pêche, concernent l'achat d'ingrédients de traitement (sel, eau de mer, etc...) et le paiement de la main-d'oeuvre de portage du poisson frais à l'atelier, de manutention du poisson prétraité en séchage et de conditionnement du poisson séché.

3.2.3 Analyse des structures de commercialisation

Au niveau des ateliers, les comités de gestion pratiquent selon les conditions du moment l'une des trois formes de commercialisation suivantes (cf. tableaux de 1 à 5):

- vente directe du produit aux mareyeurs qui, disposant de ressources financières importantes imposent les prix d'achat aux transformatrices;

- vente de la production aux exportateurs de poisson séché (cas de l'atelier de Kayar) ou aux Organisations non gouvernementales ONG (cas de l'atelier de Joal) selon un prix préalablement négocié lors de la signature du contrat établi avec l'aide des encadreurs d'atelier;

- vente de la production dans les centres importants de commercialisation du poisson séché (cas de l'atelier de Missirah qui loue une camionnette à chaque voyage).

Les deux dernières formes de commercialisation de la production des ateliers sont privilégiées par les transformatrices, car elles rapportent des profits supérieurs à la première forme, où elles peuvent faire des bénéfices ou des pertes selon les lois classiques de l'offre et de la demande.

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[1] Les transformatrices spécialisées jusqu'à présent à la production d'un seul type de produit fini, fabriquent toutes sortes de poissons séchés avec les différents types de prétraitement (braisage, salage, fermentation) possibles dans l'atelier

Tableau 1

Technologie et coûts de production du kèthiakh (Atelier de Joal)

1.a Technologie fabrication du kèthiakh

Centre de pêche local: approvisionnement en sardinelles et ethmaloses par pêcheurs locaux

↓ achat par comité de gestion FCFA 500 à 2 000 le panier de poissons, transport paniers, par porteurs (FCFA 200 par panier) ou charrette (FCFA 100 par panier)

Atelier séchage solaire

Fours de braisage: un seul feu pendant 1 à 3 heures: économie de temps et d'énergie (50 pour cent) par rapport au braisage artisanal; moins de fumée pendant l'opération

↓

Main-d'oeuvre braisage spécialisée

↓

Abri de manutention: décorticage des poissons braisés par:

- transformatrices
- jeunes hommes ou femmes ruraux FCFA 50 par bassine poissons

↓

Dessiccateurs solaires: chargement et surveillance du séchage par transformatrices, séchage pendant un jour et demi pour poisson braisé

↓

Abri de stockage: poisson braisé - séché sur claies

↓ Prix de vente[1]: FCFA 100-200
Conditionnement en ballot ou panier selon mareyeurs et destination; frais d'ensachage: FCFA 100 par ballot ou panier

Aire de commercialisation: Pesage Frais de pesage: FCFA 50 par ballot ou panier

↓

écoulement par

↙ ↓ ↘

mareyeurs ONG Comité de gestion à Tivaoune

1.b Détermination des revenus des transformatrices (1 semaine de traitement)

Coût de production		FCFA	% coût de production
Prix matière première: 20 paniers x FCFA 1500 + 20 paniers x FCFA 1250:		55 000	80,41
Consommation intérieure			
bois	4 500		
sel	1 100		
Total		5 600	8,19

---

[1] Le kg de kèthiakh fabriqué par braisage au sol coûtait au même moment FCFA 40 à 70. Mais il est plus avantageux de vendre par le comité de gestion la production sur les principales zones de consommation où les prix dépassent FCFA 190/kg

1.b Détermination des revenus des transformatrices (1 semaine de traitement) (cont'd)

Coût de production		FCFA	% coût de production
Coût main-d'oeuvre			
livraison poisson frais charrette	4 000		
chargeur fours	1 300		
décorticage poissons braisés	2 000		
frais allumage	500		
Total		13 500	19,60
Total coûts de production		68 400	
poids kéthiakh	1 180 kg		
Chiffre d'affaires (FCFA 110 x 620) + (FCFA 100 x 560)		124 200	
Revenus pour une semaine de production	55 800		

Tableau 2

Technologie et coûts de production du guédj (Atelier de Missirah)

2.a Technologie fabrication du guédj

Centre de pêche local: approvisionnement en silures, capitaines, requins etc., par pêcheurs locaux

Atelier de séchage solaire: achat par comité de gestion selon lot de poissons ou espèces. Transport par transformatrices

↓

cuves de fermentation: fermentation en saumure pendant 12 heures en moyenne. Opérations de fermentation par transformatrices

↓

abri de manutention: opérations de parage et lavage par transformatrices et main-d'oeuvre locale

↓

dessiccateurs: chargement et surveillance du séchoir par transformatrices. Préséchage et ouverture porte séchoir pendant 4-5 heures; séchage pendant 1 à 2 jours

↓

abri de stockage: poisson fermenté-séché sur claies

conditionnement en ballots par main-d'oeuvre locale

location d'un véhicule pour commercialisation extérieure

Zones de commercialisation
- MBacké
- Tamba Counda (à 500 km)

Vente poisson transformé au niveau local faible (5 à 10 % des quantités commercialisées)[1]

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[1] Missirah est une localité rurale semi désenclavée où l'usage de la main-d'oeuvre locale durant les opérations de production est peu developpé comme ailleurs

2 .b Détermination des revenus des transformatrices

_ Détermination des coûts de production (une semaine de production)

		FCFA	% Coût de production
Prix matière première		76 290	84,88
Consommations secondaires			
eau de mer lavage	1 230		
sel	6 500		
Total		7 735	8,61
Coût main-d'oeuvre		5 855	6,51
Total coûts de production		89 880	-

2.c Détermination des revenus des transformatrices (35 jours de production) par vente directe sur zones de commercialisation

Coûts de production du chargement FCFA	Lieux d'écoulement	Frais de transport FCFA	Chiffre d'affaire	Revenus
50 000	MBacké	13 100	90 050	26 950
52 000	"	13 500	105 150	39 650
90 000	Tamba Counda	16 500	190 000	88 500
93 500	"	18 000	202 500	91 000
94 200	"	19 000	206 500	93 300

Tableau 3

Technologie et coûts de production du tambadiang
(Atelier de MBour)

3.a Technologie fabrication du tambadiang

Centres de pêche locaux voisins: approvisionnement en espèces pélagiques et petites espèces par pêcheurs locaux et mareyeurs

achat par comité de gestion

livraison poissons par charrettes ou camionnettes

↓

Atelier de séchage solaire

Cuves de salage-fermentation: salage à sec et semi-fermentation pendant 12 à 24 heures selon taille des espèces et température air ambiant

↓

Abri de manutention: écaillage et lavage poissons salés et semi-fermentés

Main-d'oeuvre masculine paiement par cuve

↓

Dessiccateurs: chargement par transformatrices

Surveillance séchage par hommes pendant 1 à 2 jours selon voeux des mareyeurs

↓

Abri de stockage: poisson séché sur claies

Conditionnement en ballots ou paniers selon mareyeurs et destination

↓

Frais de conditionnement: FCFA 50 à 100 selon ballot ou panier

Vente aux mareyeurs: selon lot ou pièces de poisson séché avant conditionnement

3.b Détermination des revenus des transformatrices

Détermination des coûts de production (par espèce)

	Lagna pagna (1 camionnette)(FCFA)	Yaboye (FCFA)
prix matière première	30 000 (71,52 %)	12 000 (65,93 %)
consommations intermédiaires: sel	1 500 (3,57 %)	800 (4,93 %)
coût main-d'oeuvre		
portage	2 000	1 200
parage	7 500	3 400
surveillance séchage	950	800
Total	10 450 (24,91%)	5 400 (29,67 %)
Total coûts de production	41 950 FCFA	18 200 FCFA

3.c Détermination des revenus des transformatrices (par espèces et production)

Espèces	Achat matière première FCFA	Frais de traitement FCFA	Coûts de production FCFA	Chiffre d'affaires FCFA	Revenus des transformatrices
Ethmalose	15 000	3 400	18 400	28 500	10 100
Sardinelle	16 000	6 700	23 700	36 700	13 000
Khour-khour	23 000	7 700	30 700	48 500	17 800
Lagna-lagna	26 000	5 950	31 950	43 975	12 025

Tableau 4

Tambadiang

Technologie fabrication du saly

Centre de pêche: ravitaillement en matières premières (thonine, requins, etc.)

transport par charrette (100 FCFA par panier à Kayar)

Atelier de séchage:

abri de prêtraitement: écaillage, ouverture par le dos, éviscération, lavage: opérations par main-d'oeuvre locale et transformatrices

cuves de salage-lavage: salage à sec par transformatrices (15 à 20 % de sel durant 2 à 4 jours)

lavage et égouttage poissons salés: par transformatrices

dessiccateurs: chargement et surveillance séchage par transformatrices

séchage solaire 2 jours

abri de stockage poisson salé-séché sur claies conditionnement par main-d'oeuvre locale

vente aux mareyeurs - exportateurs à raison de FCFA/kg 200-250

Tableau 5

Caractéristiques générales s'appliquant à tous les ateliers

5.a Calcul de l'amortissement total mensuel

	Coût total (FCFA)	Durée de vie	Amortissement mensuel FCFA
Dessiccateurs solaires (claies, cadre, dallage)	280 000	4 ans	5 834
Fours de braisage	76 000	4 ans	1 584
Cuves de fermentation salage lavage	40 000	4 ans	834
Abri de manutention	40 000	3 ans	1 112
Abri de stockage	40 000	3 ans	1 112
Clôture	26 000	3 ans	723
Plastique et polyéthylène clair	60 000	15 mois	4 000
Couteaux, bassines, seaux, sacs d'emballage, lampes, éplucheurs	24 000	12 mois	2 000
Total	-	-	17 199

5.b Détermination des revenus des transformatrices

Ces revenus dépendent du type de poisson transformé, la part de travail des transformatrices et de la main-d'oeuvre locale et des opérations de prétraitement (ainsi le coût du sel dans la fabrication du poisson salé-séché représente 12 % environ du total des coûts de production). Dans les centres de traitement ruraux, l'usage de la main-d'oeuvre locale est relativement limité.

Le cahier d'exploitation tenu au niveau de chaque atelier va permettre au bout d'une année de suivi d'évaluer correctement les coûts de production par la comptabilisation du travail propre des transformatrices, des coûts d'investissement en équipement de traitement et de conditionnement.

3.2.4 Répartition des bénéfices de production

Après réunions et discussions, les transformatrices des différents ateliers se partagent les bénéfices tirés de chaque vente de la production de la façon suivante:

- 80 % des bénéfices reviennent aux transformatrices en activité;
- 15 % des bénéfices reviennent au projet afin de faire face aux réparations et extensions des capacités de traitement des ateliers;
- 5 % des bénéfices vont au gardiennage de l'atelier.

4. PERSPECTIVES ET RECOMMANDATIONS

Au bout de quelques mois de fonctionnement des ateliers, les résultats sont nombreux et variés. Quant aux problèmes et perspectives, on peut les résumer ainsi:

4.1 Les dimensions modestes des ateliers ne permettent guère d'accueillir toutes les femmes souhaitant y travailler. Ainsi, plusieurs années sont nécessaires pour permettre le passage de toutes les équipes formées de six transformatrices par mois dans l'atelier de MBour. Toutefois il faut continuer l'étude au niveau des quatre ateliers pour cerner tous les aspects techniques et socio-économiques avant toute extension; on peut peut-être augmenter les capacités de traitement de chaque atelier afin d'accélérer le passage des femmes en portant l'équipe en activité à dix personnes au maximum.

4.2 L'approvisionnement en matière première des ateliers est souvent irrégulier dans le temps et l'espace; c'est le reflet de l'état d'inorganisation quasi générale dans le secteur de la pêche artisanale. Les contacts des comités de gestion avec les pêcheurs et les mareyeurs ont permis d'améliorer le système d'approvisionnement des ateliers. Il paraît indispensable de regrouper tous les acteurs du centre de débarquement en une structure de concertation afin de prendre en compte les intérêts économiques, sociaux et professionnels de chacun.

En outre, les récentes opérations de récupération des rejets (cf. annexe 3) par transbordements pirogues-chalutiers sont à intensifier pour aider à la résolution du problème d'approvisionnement en matières premières des centres de traitement artisanal 1/.

4.3 La modicité du fonds de roulement des ateliers entraîne un manque de liquidité des transformatrices après 2 à 4 jours de production, qu'elles écoulent aux conditions des mareyeurs pour disposer de nouvelles ressources financières. Ainsi, pour limiter les blocages financiers et techniques des ateliers, il s'avère indispensable:

- d'augmenter le fonds de roulement de chaque atelier pour permettre aux transformatrices de produire pendant toute la semaine;

- de mettre à la disposition des quatre ateliers une camionnette pour la commercialisation de leur production, chaque atelier utilisant le véhicule un jour de la semaine. Les frais de commercialisation seront à la charge des ateliers (paiement du carburant) et du projet (paiement du chauffeur et entretien du véhicule).

En outre, l'amélioration de l'hygiène au sein de chaque atelier passe par:

- le dallage de la cour intérieure des ateliers pour supprimer le développement des insectes qui détruisent le poisson séché;

- l'éclairage des ateliers avec des lampes à gaz pour permettre aux transformatrices de travailler les arrivages nocturnes de poisson frais dans de bonnes conditions et en toute sécurité.

4.4 Le fait de travailler en groupe de six transformatrices est une innovation sociale importante dans l'organisation du travail dans les centres de traitement artisanal. L'essentiel est de parfaire la méthode au niveau des ateliers afin de permettre l'exécution correcte des engagements vis-à-vis des mareyeurs, et des contrats de production que leur passent certains exportateurs de poisson séché ou certaines ONG 2/. Il s'avère indispensable d'assurer un encadrement technique très efficace afin de:

- permettre un suivi plus fonctionnel des opérations technologiques et d'asseoir une comptabilité des ateliers plus saine;

- maintenir une discipline et un ordre stricts dans chaque atelier;

- veiller à ce que les transformatrices aient une meilleure connaissance du marché du poisson et de passer en revue les variations de prix du produit fini au niveau du centre de traitement, à l'intérieur et à l'extérieur du pays.

4.5 L'efficacité des techniques améliorées de pré-traitement et de séchage du poisson a amené les transformatrices à ne plus utiliser d'insecticides comme le DDT ou le PROPUXUR pendant les opérations de traitement. Néanmoins, il s'avère indispensable de mener au cours du suivi technique et socio-économique des ateliers, les opérations d'accompagnement suivantes:

- amélioration de la conservation du poisson séché afin de limiter au minimum les pertes au stockage dues aux insectes;

- étude de la qualité et de l'acceptabilité des productions des ateliers par l'Institut de Technologie Alimentaire en vue de l'élaboration de normes de commercialisation du poisson séché;

1/ Les transformatrices traitent les espèces de faible valeur commerciale rejetées à la mer par les chalutiers. Celles-ci comprennent notamment des raies, des Balistes capriscus, des chinchards, des Pagellus erythrinus, des crustacés et mollusques juvéniles ou adultes. Ces rejets s'élèvent à 67 % des captures totales chalutières selon l'étude récente du COPACE (cf. annexe 3)

2/ ONG: Organisations non gouvernementales d'aide

- étude et réalisation de dessiccateurs solaires de capacités plus grandes, avec des matériaux disponibles localement (possibilités d'abaissement des coûts de construction des ateliers);

- étude de systèmes de récupération des sous-produits et des déchets de traitement pour des raisons hygiéniques et économiques;

- étude des possibilités d'écoulement du poisson transformé en Afrique de l'Ouest où un important marché existe.

4.6 Les capacités d'innovation et d'investissement des transformatrices ne sont pas à négliger. Il s'agit d'approfondir l'étude de ces facteurs, en plus de celle des possibilités de subvention ou de mise en place de systèmes de crédit aux transformatrices.

5. CONCLUSION

Les installations d'ateliers de séchage solaire dans les centres de traitement artisanal représentent un progrès incontestable dans les actions de recherche appliquée sur la technologie du poisson; l'écho rencontré chez les transformatrices en est le témoin. Celles-ci ont grandement contribué à rendre les innovations technologiques bien adaptées aux conditions locales propres à chaque centre de traitement.

Les ateliers de séchage ont permis:

- l'introduction du travail en groupe malgré le caractère d'individualisme dominant dans le secteur;

- l'usage de meilleures conditions d'hygiène et des techniques améliorées de pré-traitement et de séchage solaire du poisson;

- la rationalisation de la chaîne de traitement des différents produits séchés; et

- l'indentification d'autres problèmes techniques et sociaux à résoudre.

L'encadrement technique des ateliers devra porter en plus de la technologie et des enquêtes socio-économiques, sur:

- la gestion et la commercialisation;

- une initiation aux actions coopératives;

- une initiation aux structures de crédit.

L'essentiel est d'intensifier les capacités de création et d'initiative des transformatrices en s'appuyant sur leurs responsabilités et leur autonomie.

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ANNEXE 1

Tonnage des produits transformés de 1977 à 1982

Produits finis	QUANTITES OBTENUES (en tonnes)					
	1977	1978	1979	1980	1981	1982
Saly - salé - séché	953	988	707	758	528	477
Métorah ou poisson fumé	1 387	1 381	1 027	698	680	657
Tambadiang ou poisson séché entier	3 017	2 894	3 338	3 928	939	713
Kéthiakh ou poisson braisé - séché	7 169	6 002	5 728	6 014	7 047	6 458
Guèdj ou poisson fermenté - séché	3 869	4 232	3 751	3 403	3 496	3 436
Toufa (murex séché) - Yeet (cymbium fermenté séché)	1 632	3 580	5 200	7 403	2 803	1 567
Autres produits (pagne, yokhoss, etc .)	1 794	112	97	132	2 272	4 000
Total produits finis	19 791	19 181	19 848	22 297	17 765	16 049

SOURCE DOPM

Le rendement en produits finis des poissons traités par les procédés artisanaux varie entre 30 et 60 %, compte-tenu de la diversité des matières premières et des procédés. Ainsi, la transformation artisanale traite environ 60 000 tonnes de poissons frais par an.

ANNEXE 2

Types de prototypes expérimentés durant la phase I du projet

Prototype I: Système à base rectangulaire surmonté d'un toit à double pente; il est formé de poutrelles de bois de mangrove avec une porte d'accès aménagée sur l'une des faces latérales. Il peut être réalisé en banco;

Prototype II: Système combiné à préchauffage de l'air par insolateur plan et à chauffage direct par le haut de la cabine de séchage;

Prototype III: Système combiné à préchauffage de l'air par insolateur plan et à chauffage direct à travers les faces latérales et le dessus de la chambre. Son mode de fonctionnement diffère de celui du prototype II par l'emplacement des couvertures noires et claires et par la cheminée qui améliore le tirage;

Prototype IV: Modèle séchoir tente solaire. C'est un système à chauffage direct dont la fabrication est relativement facile;

Prototype V: Système combiné à collecteur à 15° (latitude de Dakar) adapté sur une cabine de séchage dont la face sud est également inclinée;

Prototype VI: Système à chauffage direct à base rectangulaire et dont la face supérieure est légèrement inclinée. Le cadre est en bois d'oeuvre ou banco selon les conditions locales.

ANNEXE 3

Estimations des quantités rejetées en mer pour les chalutiers opérant au large des côtes sénégalaises[a]

Chalutiers	Quantités débarquées (tonnes)	Rejets	Captures (tonnes)
Sénégalais	28 848	56 946 (67 %)	84 994
Français	7 942	16 124 (67 %)	24 066
Espagnols	6 337	12 866 (67 %)	19 203
Italiens	3 546	7 199 (67 %)	10 745
Sous-total	45 873	93 135 (67 %)	139 008
Polonais	75 893	0[b]	75 893
Total	121 766	93 135	214 901

SOURCE FAO/COPACE

Les rejets en mer de la pêche chalutière que l'on commence à récupérer par transbordement pirogues-chalutiers, sont constitués de poissons à faible valeur commerciale tels que les raies, les Balistes capriscus, les crustacés et mollusques juvéniles ou adultes, les espèces pélagiques (chinchards, Pagellus erythrinus, etc.). Les différents poissons rejetés sont actuellement utilisés par les transformatrices et leur récupération va permettre de résoudre le problème de l'approvisionnement en matière première des centres de traitement artisanal du poisson

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[a] Cf. Monoyer P.J. et Bellemans M.: Une étude préliminaire sur les rejets en mer - Etude COPACE/FAO octobre 1982

[b] Il semblerait que les chalutiers pélagiques polonais ne rejettent que très peu de poissons

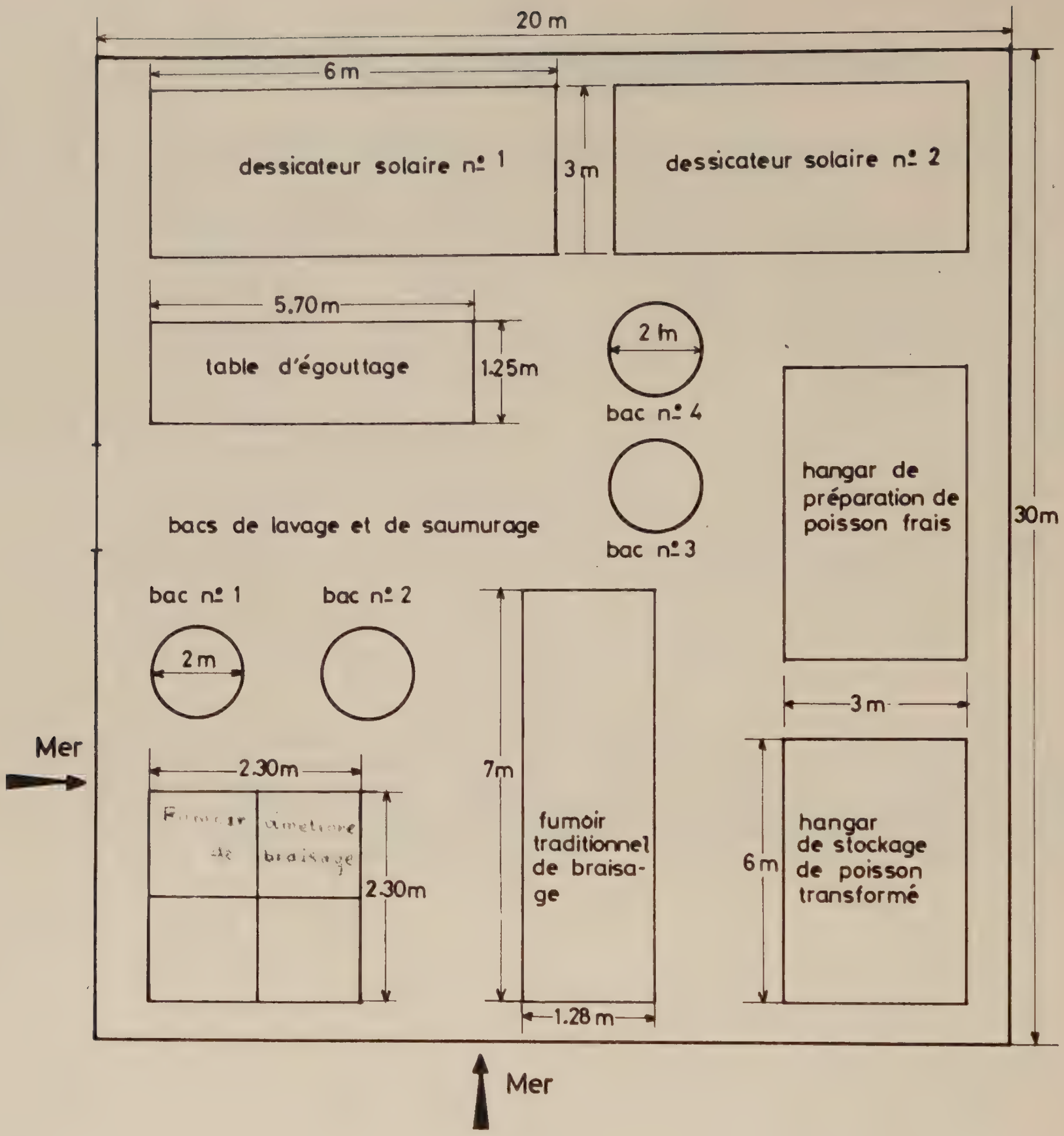
20 m
6 m
dessicateur solaire n° 1
3 m
dessicateur solaire n° 2
5.70 m
table d'égouttage
1.25 m
2 m
bac n° 4
bac n° 3
hangar de préparation de poisson frais
30 m
bacs de lavage et de saumurage
bac n° 1
bac n° 2
2 m
3 m
Mer
2.30 m
Fumoir amélioré
de braisage
2.30 m
7 m
fumoir traditionnel de braisage
6 m
hangar de stockage de poisson transformé
1.28 m
Mer

Figure 1 Modèle d'atelier de sèchage solaire

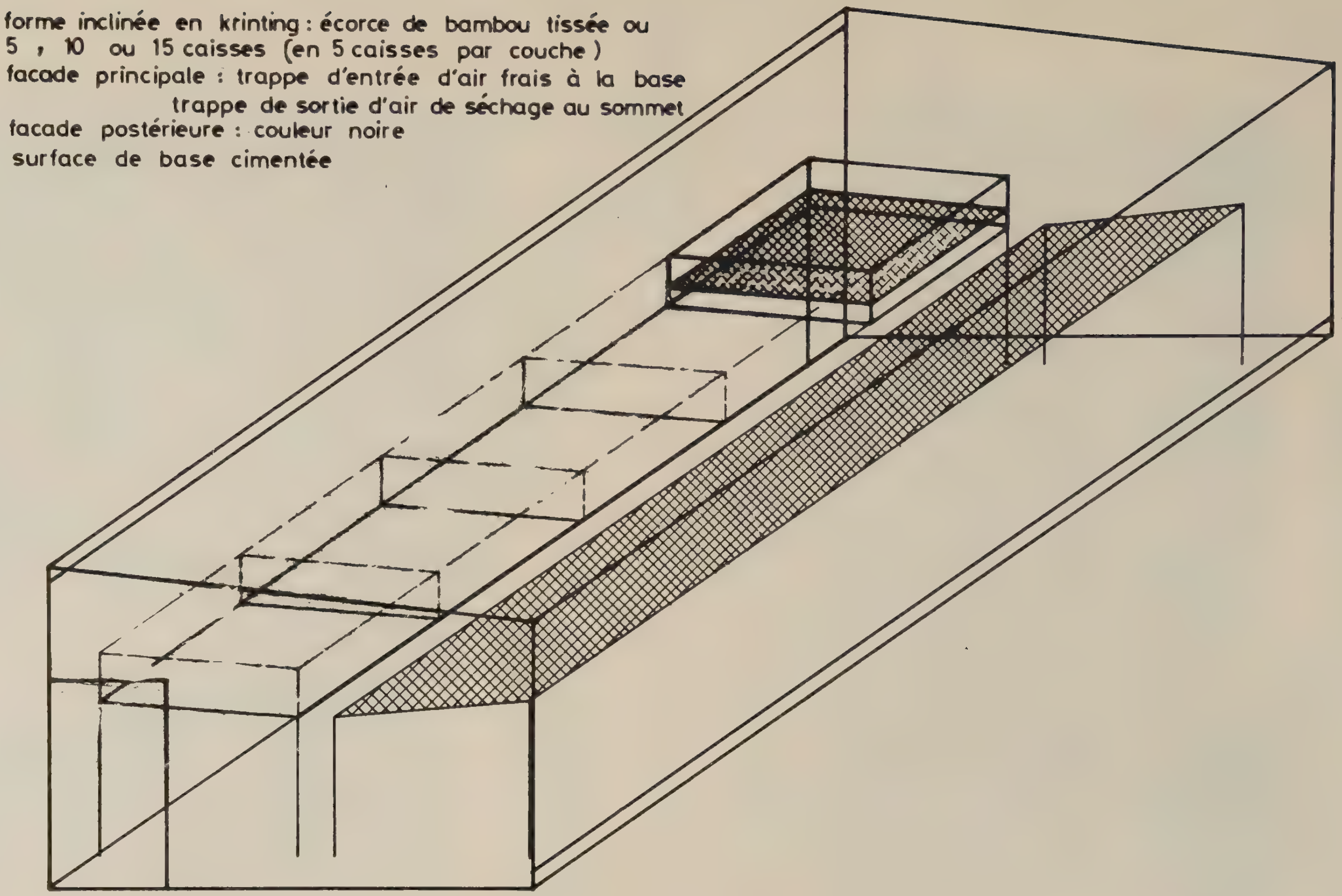
forme inclinée en krinting : écorce de bambou tissée ou
5 , 10 ou 15 caisses (en 5 caisses par couche)
facade principale : trappe d'entrée d'air frais à la base
trappe de sortie d'air de séchage au sommet
facade postérieure : couleur noire
surface de base cimentée

Figure 2 Claies de séchage dans le dessiccateur solaire

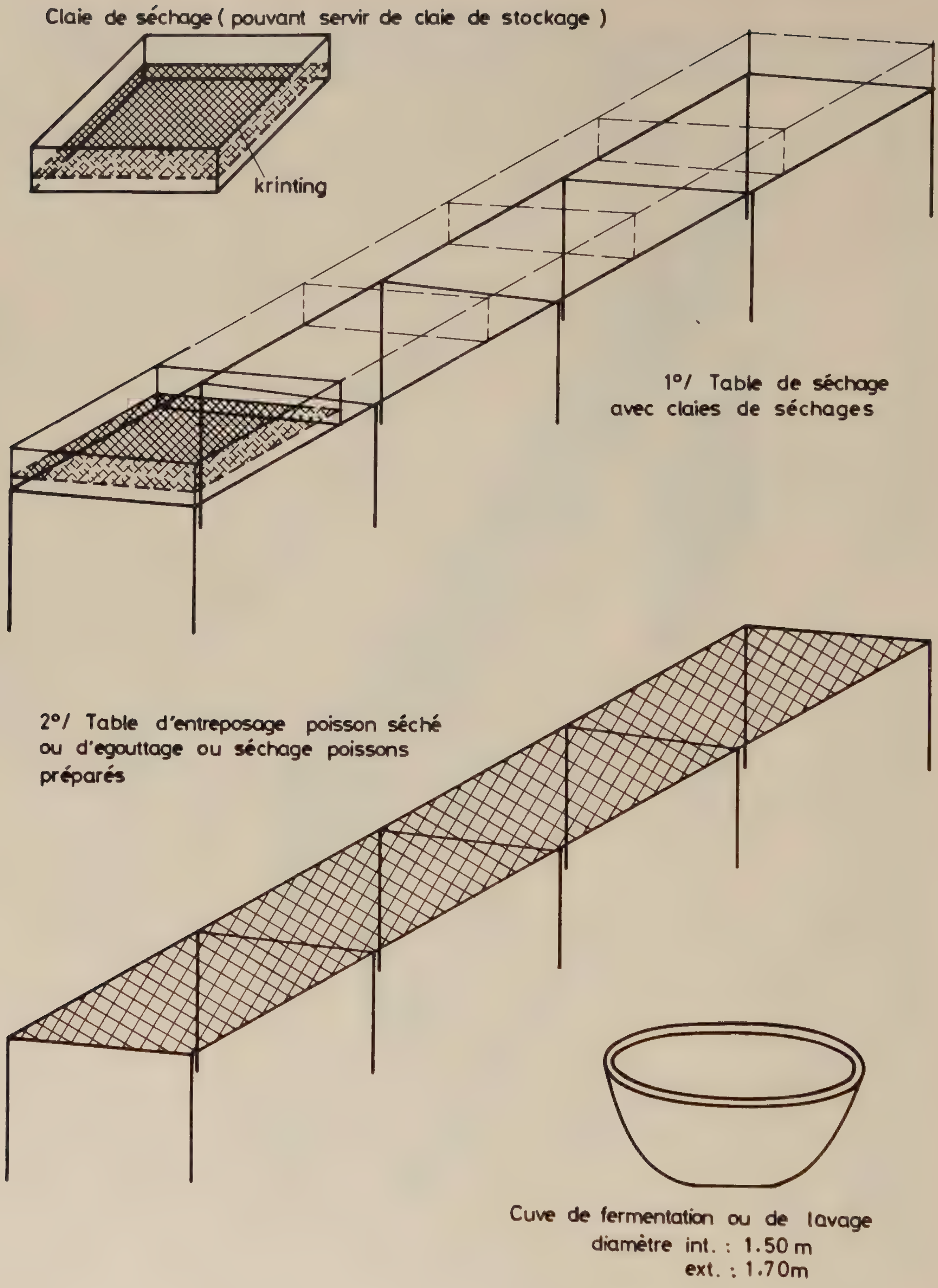
Claie de séchage (pouvant servir de claie de stockage)
krinting
1°/ Table de séchage avec claies de séchages
2°/ Table d'entreposage poisson séché ou d'egouttage ou séchage poissons préparés
Cuve de fermentation ou de lavage
diamètre int. : 1.50 m
ext. : 1.70m

Figure 3 Structures de préparation ou d'entreposage du poisson en cours de transformation, ou transformé

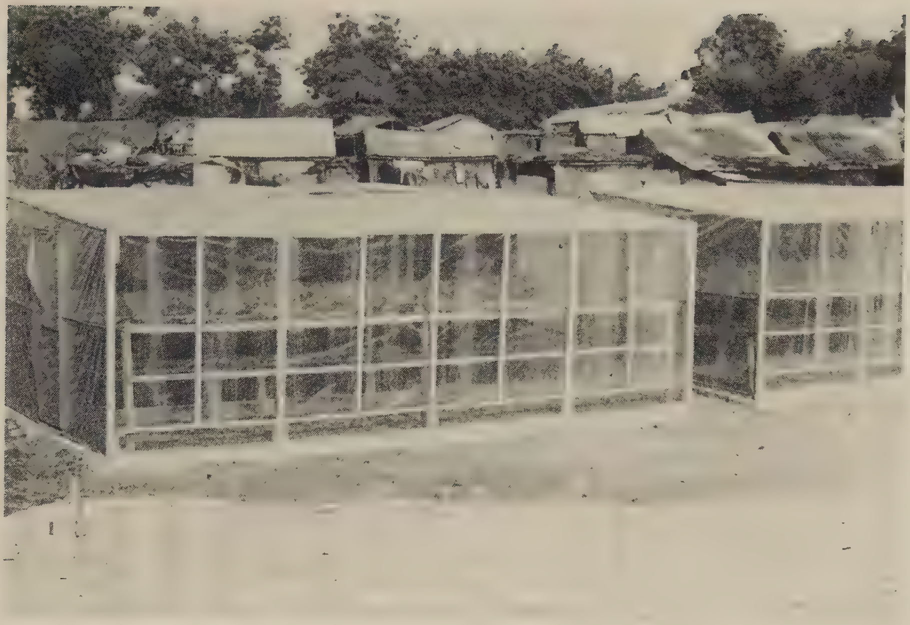

Photo 1 Dessiccateurs solaires à l'atelier de séchage solaire de MBour (vue de face)

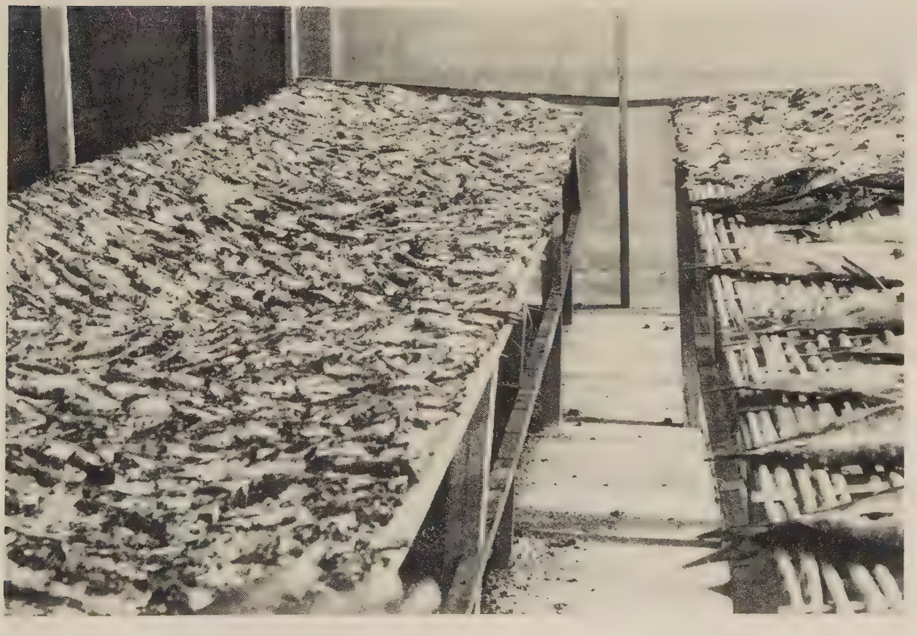

Photo 2 Poisson braisé, fumé en cours de séchage dans dessiccateur solaire (atelier de MBour)

ETUDE DU POISSON BRAISE-SECHE (KETHIAKH) AU SENEGAL

par

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RESUME

Outre l'analyse de l'importance et du rôle du kéthiakh compte tenu de la forte augmentation des captures artisanales de sardinelles (Sardinella aurita et Sardinella eba) et d'ethmaloses (Ethmalosa fimbriata) au Sénégal, cette communication porte sur les deux méthodes de braisage artisanal et amélioré du poisson frais, le séchage traditionnel et solaire du poisson braisé, la conservation et la distribution du poisson braisé-séché et l'évolution des caractéristiques biochimiques et organoleptiques pendant les différentes phases de fabrication du kéthiakh.

1. INTRODUCTION: LA TRANSFORMATION ARTISANALE "MODERNE" EN KETHIAKH (cf. figure 1)

Le kéthiakh est le produit transformé le plus important au Sénégal (voir tableau 1). A MBour, le plus important des centres de traitement, les quantités transformées se sont accrues de 61% en quatre ans avec une proportion de plus en plus forte de kéthiakh (73 %).

L'apparition du kéthiakh chez les lébous du Cap-Vert coïncide avec celle des filets maillants encerclants dans les années 1960 et le récent développement de ce produit coïncide avec celui des sennes tournantes expérimentées et diffusées sous l'impulsion d'un projet FAO à partir de 1970. Ces nouveaux engins de pêche ont permis la capture en grande quantité de petits pélagiques (sardinelles et ethmaloses notamment) que l'on ne peut transformer en poisson fermenté-séché (guédj).

Le kéthiakh s'est développé avec un outil fondamentalement nouveau et bien approprié à une activité commerciale de grande ampleur: l'achat et la vente à l'unité de poids. La transformation en poisson braisé-séché utilise impérativement un produit frais: sardinelles et ethmaloses qui représentent la majorité des espèces pélagiques capturées. La forte demande de kéthiakh bénéficie à la fois aux transformatrices et aux pêcheurs. Les femmes peuvent traiter chacune entre 800 kg et une tonne de poisson par jour et se ravitaillent directement auprès des pêcheurs locaux ou des centres de pêche à un prix égal ou supérieur à ce qu'offrent les mareyeurs. Cette forte demande permet le soutien des cours de sardinelles et d'ethmaloses qui peuvent passer en quelques heures de FCFA 500 à FCFA 3 000 le même panier (50 à 80 kg) selon le volume des débarquements.

Le kéthiakh est très apprécié des consommateurs urbains et ruraux comme source de protéines animales dans les plats à base de céréales (riz, mil, maïs). En outre, il est exporté en Guinée et au Mali. Les déchets de traitement sont utilisés comme fertilisants par les maraîchers ou comme combustible par les transformatrices.

L'atelier de kéthiakh se limite à une aire de braisage, ou à des fours en parpaings (cf. figure 2), des claies de séchage, quelques bassines, des feuilles de plastique pour la protection du poisson contre les intempéries (pluie, condensations nocturnes notamment) (cf. photos 1, 2, 3). Cependant, les 2 principales agglomérations urbaines de production (MBour et Joal) sont envahies par une fumée épaisse au moment du braisage du poisson au sol. Cette pollution représente un des facteurs expliquant la décision des autorités de transférer les centres de traitement en dehors des deux villes.

2. MATERIELS ET METHODES

Cette étude a débuté parallèlement à la phase d'adaptation du séchoir solaire aux conditions locales de traitement et s'est poursuivie avec l'installation de l'atelier de séchage solaire de MBour.

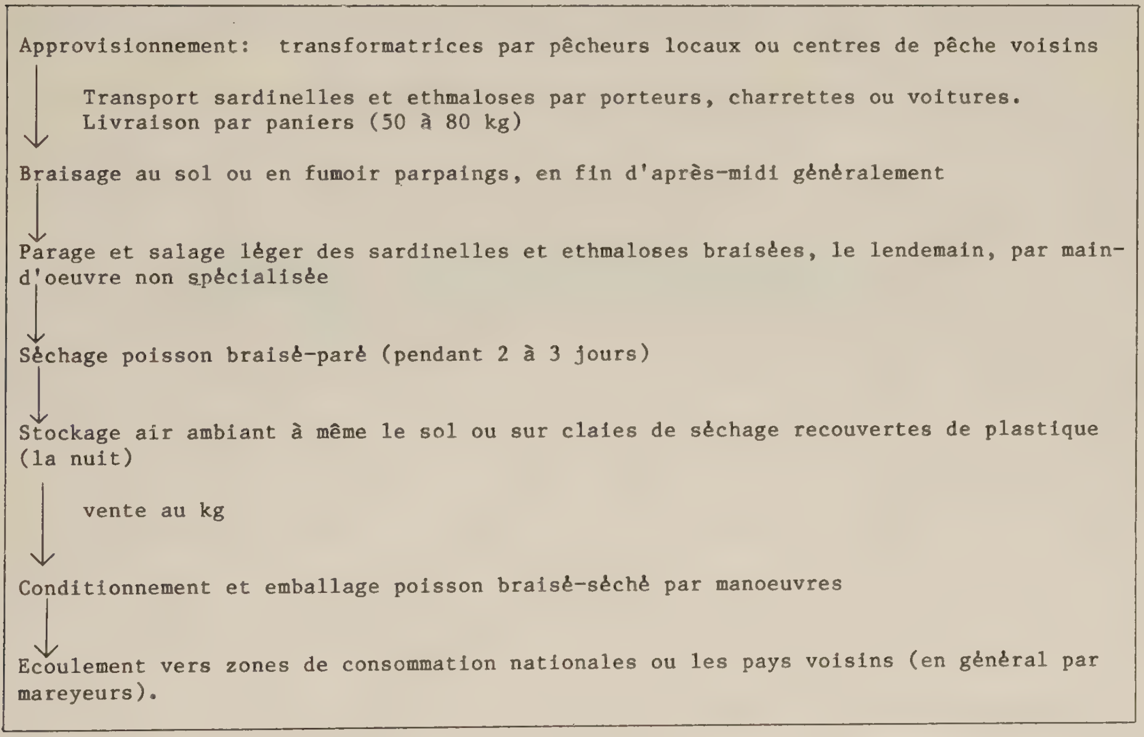
Tableau 1

Importance du kèthiakh dans le tonnage des produits transformès de 1975 à 1982

Produits finis	Quantitès obtenues (en tonnes)							
	1975	1976	1977	1978	1979	1980	1981	1982
Kèthiakh ou poisson braisè-sèchè	14 688	12 669	7 169	6 002	5 728	6 014	7 047	6 458
Guèdj ou poisson fermentè-sèchè	10 832	7 512	3 869	4 232	3 751	3 403	3 496	3 436
Total produits finis	35 836	32 271	19 791	19 181	19 848	22 297	17 765	16 049

SOURCE DOPM

Le salè-sèchè, le poisson fumè, le poisson sèchè entier, le cybium fermentè-sèchè, le murex sèchè, le pagne, l'huître cuite sèchèe reprèsentent les principaux autres produits transformès. Le rendement en produits finis des poissons traitès par les procèdès artisanaux varie entre 30 et 60%, compte tenu de la diversitè des matières premières et des procèdès. En tenant compte de l'autoconsommation, la transformation artisanale traite environ 60 000 t de poisson par an.



Approvisionnement: transformatrices par pêcheurs locaux ou centres de pêche voisins

↓ Transport sardinelles et ethmaloses par porteurs, charrettes ou voitures. Livraison par paniers (50 à 80 kg)

Braisage au sol ou en fumoir parpaings, en fin d'après-midi gènèralement

↓

Parage et salage lèger des sardinelles et ethmaloses braisèes, le lendemain, par main-d'oeuvre non spècialisèe

↓

Sèchage poisson braisè-parè (pendant 2 à 3 jours)

↓

Stockage air ambiant à même le sol ou sur claies de sèchage recouvertes de plastique (la nuit)

↓ vente au kg

Conditionnement et emballage poisson braisè-sèchè par manoeuvres

↓

Ecoulement vers zones de consommation nationales ou les pays voisins (en gènèral par mareyeurs).

Figure 1 Technologie de fabrication et ècoulement du kèthiakh artisanal

2.1 Matèriels

2.1.1 Fabrication du kèthiakh

Deux techniques de braisage des sardinelles et des ethmaloses sont pratiquèes, en dèbut d'après-midi:

- braisage au sol (cf. figure 2): grillage du poisson par un lit de résidus de paille, d'herbes séchées ou de coques d'arachide en couches alternées pendant deux heures, puis maturation des poissons braisés le reste de la nuit, avant parage et saupoudrage léger de sel;

- braisage par fours en parpaings (cf. figure 2): grillage du poisson pendant 1 à 2 heures et maturation des produits braisés avant parage, pendant quelques heures (la nuit en général).

Les sardinelles ou les ethmaloses braisées et refroidies complètement sont étêtées, épluchées, salées ou non et mises à sécher sur les claies ou au dessiccateur solaire (cf. photos 1, 2, 3).

2.1.2 Préparation des échantillons

Pour étudier l'effet du braisage artisanal ou amélioré et du séchage naturel ou solaire sur la composition chimique des sardinelles et ethmaloses, nous avons recueilli des échantillons de poissons frais, braisés et séchés.

Pour chaque catégorie, un échantillon de 6 poissons a été prélevé. Les échantillons sont acheminés au laboratoire.

L'échantillon débarrassé des têtes, nageoires, queues, arêtes et peau, est coupé en petits morceaux de 100 g, puis broyé au Waring blendor. Lorsque la mouture est suffisamment fine, l'échantillon est ensuite mis en sachets stériles et conservé au frais pour analyse.

Les échantillons frais et braisés ont été lyophilisés[1/] après dosage préalable des teneurs en matière sèche et en protéines, puis envoyés en Belgique[2/] pour détermination des teneurs en acides aminés.

2.2 Méthodes

Pour suivre les modifications de la qualité du poisson en cours de pré-traitement et de séchage naturel et solaire, nous avons étudié:

- les caractéristiques physiques de l'air de séchage à l'aide du téléthermomètre ULTRAKURST (température), d'hygromètres RICHARD (humidité relative), d'anémomètres (vitesse de circulation);
- l'évolution de la qualité chimique du produit à sécher ou fini: teneurs en eau, protéines, pH, matière azotée totale (M.T.A), acides aminés et histamine.

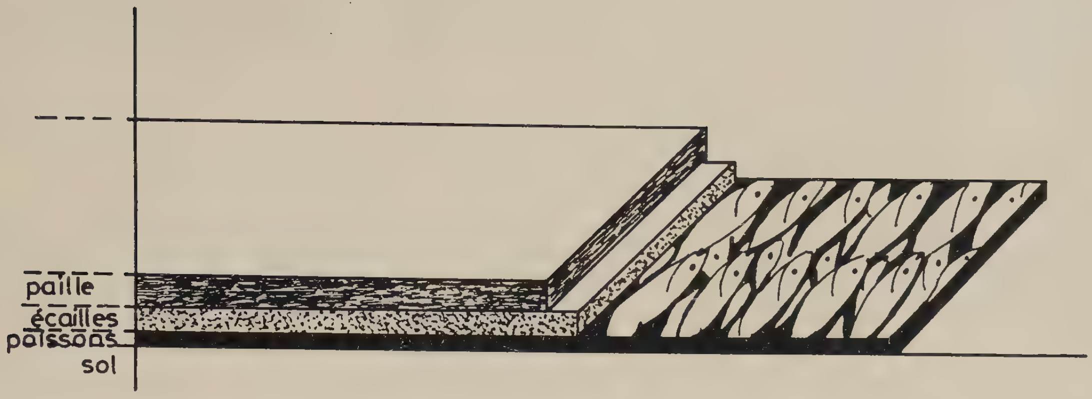
Les dosages d'acides aminés ont été effectués par chromatographie sur colonnes de résines échangeuses d'ions, selon la technique de Spackman, Stein et Moore (1958), après hydrolyse par HCl6N à 115°C pendant 22 heures à l'autoclave.

La cystéine et la méthionine sont déterminées après oxydation préalable par l'acide performique selon la méthode de Schram et al. (1954).

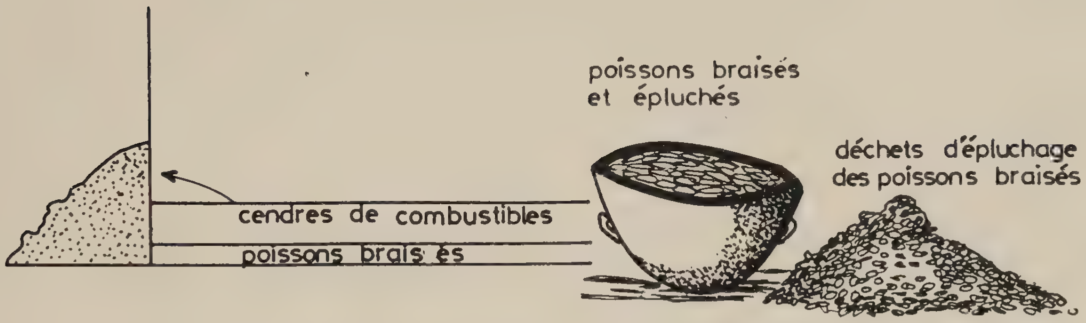
Toutes les déterminations d'acides aminés sont effectuées au moyen d'un AMINO ACID ANALYZER UNICROM BECKMAN. Quelques déterminations d'histidine sont effectuées au moyen d'un auto-analyseur TECHNICON.

[1/] Au Laboratoire national d'élevage de Dakar

[2/] Laboratoire de biochimie de la nutrition. Département de biologie animale appliquée, Louvain-la-Neuve, Belgique


paille
écailles
poissons
sol

Avant braisage : technique de préparation


poissons braisés
et épluchés
déchets d'épluchage
des poissons braisés
cendres de combustibles
poissons braisés

Après braisage : opérations de manutention du poisson braisé

Figure 2a Braisage artisanal de la sardinelle ou de l'ethmalose, à même le sol

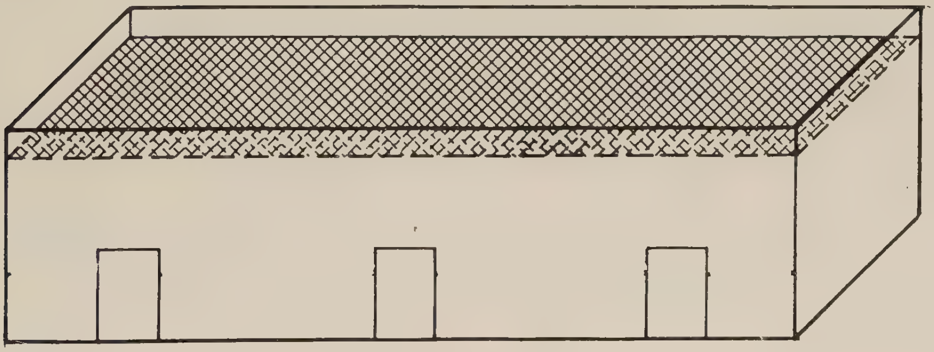


Figure 2b Fumoir traditionnel: braisage des sardinelles et des ethmaloses

Toutes les déterminations des teneurs en histamine sont effectuées par la méthode de Foo modifiée.

3. RESULTATS ET DISCUSSIONS

3.1 Conditions de fabrication du kéthiakh

3.1.1 Analyse de la consommation énergétique du braisage artisanal et amélioré

De cinq à six fagots sont utilisés pour braiser un panier de 70 kg de sardinelles ou d'ethmaloses au sol[1]. Le poids du fagot varie de 25 à 30 kg. Le pouvoir calorifique de la paille est de 3 000 à 4 000 kcal/kg de matière sèche. Comme le braisage artisanal de 10 kg de poissons frais permet d'obtenir 5 kg de kéthiakh, la dépense d'énergie varie de 8 000 à 9 000 kcal/kg de poissons frais à traiter (16 000 à 18 000 kcal/kg de kéthiakh).

Le pouvoir calorifique du bois de flambage du poisson au fumoir est de 3 400 kcal/kg de matière sèche. Le braisage nécessite:

- 84 kg de bois[2] pour braiser 70 kg de poissons frais ce qui représente une dépense d'énergie de $40,8.10^2$ kcal/kg de poissons frais ($81,60.10^2$ kcal/kg de kéthiakh);
- 40 à 50 kg de coques d'arachides pour enflammer le bois et parfaire le grillage ou flambage; ce qui représente en moyenne 350 kcal pour un pouvoir calorifique de la coque d'arachide de 4 000 à 4 500 kcal/kg de matière sèche.

Ceci donne une dépense totale d'énergie de 44.10^2 kcal/kg de poissons frais (88.10^2 kcal/kg de poisson braisé-séché au four en parpaings).

Ainsi le braisage par four (8 800 kcal/kg de kéthiakh) se traduit par une économie d'énergie d'environ 50 % par rapport au braisage par terre (160.10^2 à 180.10^2 kcal/kg de kéthiakh) et réduit considérablement la production de fumée dans le milieu environnant.

3.1.2 Contrôle des caractéristiques physiques de l'air de séchage

L'examen du diagramme d'humidité relative et de la température (cf. figure 3) pendant la journée montre que:

- à l'intérieur du dessiccateur, la température varie entre 47°C et 28°C pendant les heures d'ensoleillement, avec un palier entre 12 et 16 heures (47°C);
- l'humidité relative à l'intérieur du dessiccateur varie de 82 % et 38 %, avec un palier entre 12 et 16 heures (38 %);
- à l'extérieur du dessiccateur solaire, la température (à coeur du poisson) varie entre 36°C et 28°C sans palier;
- l'humidité relative à l'extérieur du dessiccateur solaire varie entre 86 % et 55 %, sans palier.

En outre, la circulation de l'air de séchage à l'intérieur du four, par convection naturelle est appréciable et représente plus de 30 pour cent de la vitesse de l'air ambiant ($1,90 \text{ m/s} < V_{\text{air ambiant}} < 2,80 \text{ m/s}$).

3.1.3 Conduite du séchage

Le braisage abaisse la teneur en humidité du poisson frais à moins de 68 %. Cet abaissement, de 5 à 10 % au cours du braisage artisanal et de 9 à 15 %[3] au cours du braisage au four constitue la phase de préséchage, éliminant ainsi le phénomène de "case hardening".

Le séchage naturel du poisson braisé au sol dure 2 à 3 jours. Les échantillons de kéthiakh possèdent des taux d'humidité supérieurs à 30 % au bout de 2 jours de séchage artisanal.

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[1] Les transformatrices saupoudrent de sable le lit de feuillage ou de coques d'arachides pour prolonger de 3 à 4 heures la cuisson du poisson après le grillage

[2] 2,16 m^3

[3] Par rapport à la teneur initiale en eau

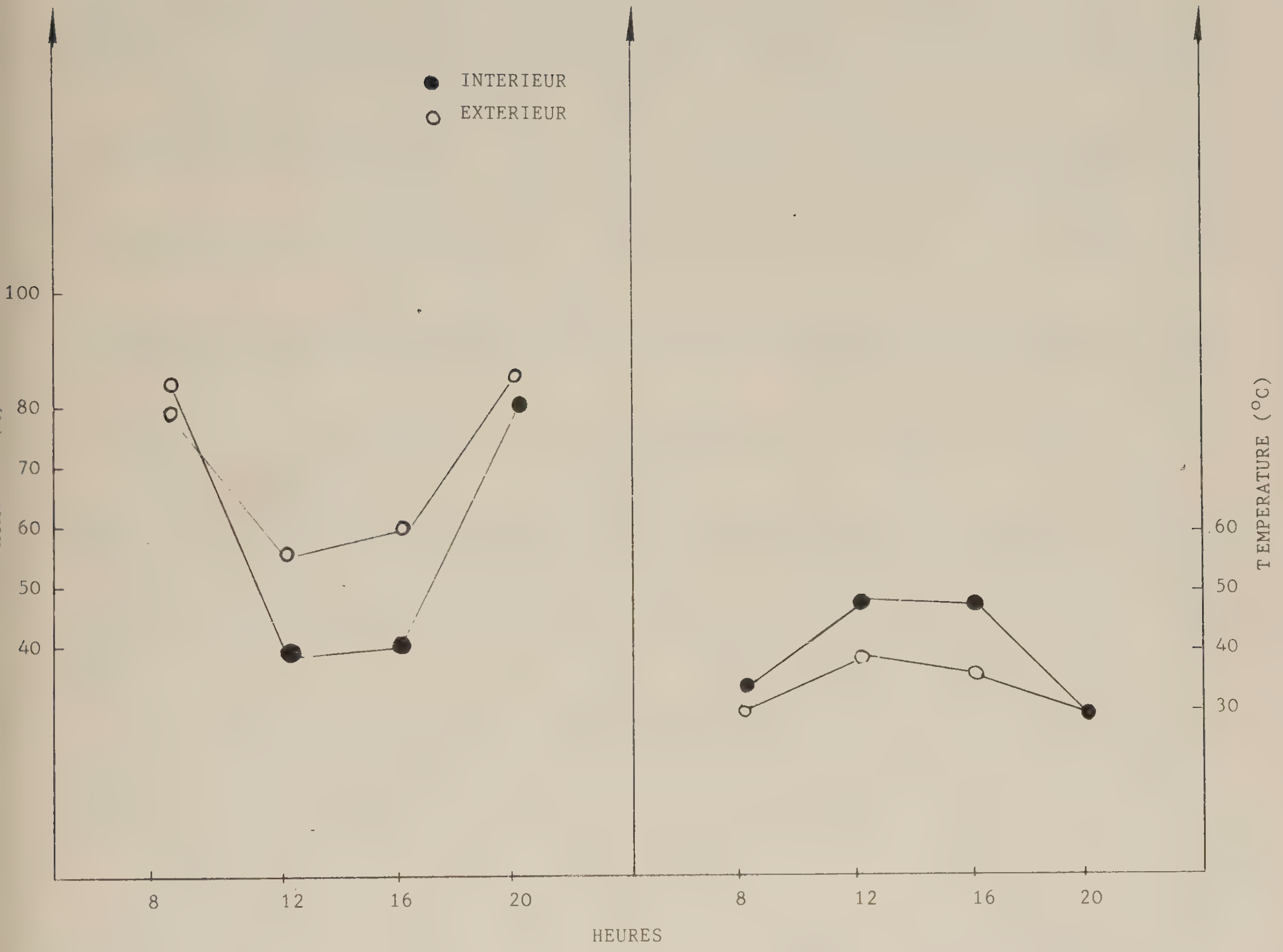

Figure 3 Variations de l'humidité relative et de la température à l'intérieur et à l'extérieur du dessiccateur solaire

La phase de séchage solaire effectif dure environ 18 heures pour le poisson braisé au sol et 14 heures pour le poisson braisé au four. Ces échantillons de kéthiakh braisés au sol ou au four et séchés par dessiccateur solaire ont une teneur en humidité inférieure à 25 %.

3.2 Résultats des analyses biochimiques

3.2.1 Evolution de la composition en acides aminés de la sardinelle fraîche, braisée et séchée artisanalement (cf. tableau 2)

A la lecture du tableau 2, on peut remarquer la richesse relative de la sardinelle fraîche en lysine totale (environ 9,15 % de la matière azotée totale), méthionine et cystine qui sont tous des acides aminés essentiels pour l'homme. En outre, la teneur importante en lysine totale permet de compenser la faible teneur des aliments d'origine végétale (mil, riz, maïs) en cet élément.

Les teneurs en acides aminés diminuent pendant le braisage au sol et augmentent pendant le séchage naturel à l'exception de l'isoleucine. Le braisage et le séchage naturel affectent plus particulièrement les acides aminés basiques (histidine, lysine, arginine) et la méthionine au profit de la proline, la glycine, la tyrosine et la phénylalanine.

3.2.2 Caractéristiques particulières du kéthiakh artisanal et du kéthiakh séché au dessiccateur solaire

Comme le braisage et le séchage affectent particulièrement les acides aminés basiques des poissons à chair relativement foncée tels la sardinelle et l'ethmalose, nous avons orienté notre travail sur l'évolution du pH et des teneurs en histidine et histamine du kéthiakh à l'intérieur et à l'extérieur du séchoir solaire.

A. Qualité chimique (pH, histidine, histamine) du poisson au débarquement (cf. tableau 3)

La sardinelle et l'ethmalose, refroidies aussitôt après capture, présentent des teneurs en histamine faibles et des pH légèrement acides. Quant aux poissons non refroidis, l'altération de l'histidine en histamine est déjà significative et les pH dépassent 6,25 au bout de quelques heures suite à la concentration de bases volatiles dans la chair des poissons.

Tableau 2

Composition en acides aminés de sardinelle fraîche, braisée et braisée-séchée en grammes d'acides aminés pour 100 grammes de matière azotée totale

Acides aminés Nombre d'échantillons	Sardinelle fraîche 2	Sardinelle braisée 2	Sardinelle braisée-séchée 2
Acide aspartique	9,12	8,28	11,26
Thréonine	3,68	3,44	4,52
Sérine	3,72	2,84	3,80
Acide glutamique	13,72	11,20	16,79
Proline	2,73	2,18	5,84
Glycine	4,82	3,76	5,30
Alanine	5,41	4,71	6,06
Valine	4,85	4,59	6,68
Méthionine	3,71	2,66	3,01
Isoleucine	4,73	4,26	3,43
Leucine	7,80	6,95	8,15
Tyrosine	2,12	2,07	3,58
Phénylalanine	3,14	3,29	4,75
Lysine	9,37	8,19	10,00
Histidine	5,45	2,22	2,92
Arginine	4,86	4,38	6,80
Cystine	1,05	0,93	1,22
Matière azotée totale	63,56 9/100 g de produit lyophilisé	64,06 9/100 g de produit lyophilisé	40,82 9/100 g de produit avant lyophilisation

Tableau 3

pH et teneurs en histidine et histamine de la sardinelle et de l'ethmalose fraîches

Espèces	Poissons	pH	Histidine g/100 g de MAT	Histamine mg/100 g
Sardinelle ronde	Refroidi aussitôt après capture	5,85	5,68	1,35
	non refroidi	6,30	5,25	9,40
Ethmalose	Refroidi aussitôt après capture	5,95	5,05	0,88
	non refroidi	6,40	4,78	12,25

MAT = Matière azotée totale

B. Evolution du pH et des teneurs en histidine et en histamine du kéthiakh à l'intérieur et à l'extérieur du séchoir

Les résultats obtenus figurent dans les tableaux 4 et 5 et peuvent être interprétés à la lumière des diagrammes d'humidité relative et de température établis durant la phase de séchage.

Ainsi le kéthiakh est réalisé avec des clupéidés tous riches en histidine (sardinelles et ethmaloses). Les pourcentages d'histamine des échantillons de kéthiakh artisanal sont déjà importants avant même le braisage. Ceux-ci augmentent au cours du traitement à cause des conditions très favorables de décarboxylation de l'histidine en histamine ($28^{o}C < T < 38^{o}C$ et $6{,}00 < pH < 6{,}9$) (cf. annexe 1).

Les températures atteintes dans le séchoir permettent de diminuer les teneurs en histamine du produit. Ainsi pour obtenir un kéthiakh à teneur d'histamine faible, il s'avère indispensable de refroidir la sardinelle ou l'ethmalose dès sa capture. Le braisage au four est plus hygiénique que celui effectué au sol et s'adapte parfaitement au séchage solaire.

C. Evolution des teneurs en histidine et en histamine du kéthiakh artisanal en stockage traditionnel (cf. tableau 6)

Les résultats d'analyses d'échantillons de kéthiakh artisanal stockés à MBour et Joal (3 semaines après fabrication) montrent que les teneurs en histamine parfois élevées baissent d'une manière très appréciable au cours du stockage à moins de 10 mg/100 g comme l'ont déjà remarqué Takagi *et al.* sur le poisson séché[1/]. Quant aux teneurs en histidine, elles restent stables.

3.3 Autres caractéristiques du kéthiakh

3.3.1 Composition chimique générale du kéthiakh (cf. tableau 7)

3.3.2 Aspects organoleptiques et commercialisation du kéthiakh (cf. tableau 8)

Les conditions de séchage solaire n'altèrent ni la couleur, ni la saveur du kéthiakh séché au dessiccateur, qui présente les caractères suivants:

- absence totale de l'odeur du kéthiakh séché artisanalement;
- accroissement de la consistance de la chair.

Le kéthiakh ainsi obtenu a été apprécié des transformatrices et présente un meilleur aspect avec une teneur en humidité inférieure à 25 % après deux jours de séchage.

Tableau 4

Evolution du pH et des teneurs en histidine et histamine du kéthiakh artisanal et du kéthiakh préparé au dessiccateur solaire, à base de sardinelle ronde

	Braisage au sol			Braisage au four		
	pH	Histamine mg/100 g	Histidine g/100 g MAT	pH	Histamine mg/100 g	Histidine g/100 g MAT.
Séchage naturel						
Poisson frais	6,25	9,40	5,25	6,15	9,80	5,05
Poisson braisé	6,35	39,20	2,35	6,30	12,50	2,70
Fin 1er jour de séchage	6,45	62,20	2,48	6,35	39,70	2,90
Fin 2e jour de séchage	6,50	80,90	2,50	6,40	40,80	3,00
Kéthiakh stocké 1 semaine	6,60	20,80	2,52	6,40	16,20	3,05
Séchage solaire						
Poisson frais	6,20	8,60	5,18	6,18	7,30	5,40
Poisson braisé	6,28	22,40	2,85	6,25	14,60	3,05
Fin 1er jour de séchage	6,40	29,50	2,95	6,30	17,10	3,15
Fin 2e jour de séchage	6,40	32,60	3,01	6,30	16,20	3,25
Kéthiakh stocké 1 semaine	6,45	12,70	3,05	6,35	8,60	3,26

4. CONCLUSIONS ET RECOMMANDATIONS

Les résultats des analyses biochimiques montrent que le traitement artisanal du kéthiakh n'affecte que les acides aminés basiques et la méthionine du poisson frais. Cela se traduit par la formation de produits de décarboxydation dans le poisson séché. L'étude limitée à l'histamine dans le kéthiakh, devrait être poursuivie pour la recherche de ce produit de dégradation dans les autres types de poisson séché.

La présence d'histamine dans le kéthiath, à des teneurs parfois élevées, montre bien les manquements aux règles d'hygiène, notamment la refrigération du poisson frais sitôt après la capture.

Malgré la présence d'histamine dans le kéthiakh et les autres poissons séchés (guédj notamment), aucun cas d'intoxication histaminique (cf. annexe 2) dû à l'ingestion de poisson transformé n'a été signalé au Sénégal. Ceci peut être dû à plusieurs facteurs:

- le poisson transformé, loin de constituer la partie essentielle des repas, est utilisé généralement en petits morceaux pour donner un goût aux plats locaux qui sont à base de céréales (riz, maïs, mil);

- c'état de la médecine au niveau des populations surtout rurales, grandes consommatrices de kéthiakh.

Une enquête sommaire menée dans les régions côtières concernant les phénomènes d'allergie alimentaire montre que:

- les populations côtières connaissent très bien les manifestations d'allergie ou de pseudo-allergie alimentaire due à l'ingestion de poissons à chair rouge. Les femmes de pêcheurs et les ménagères appellent ce type d'espèces "poissons noirs". Le tassergal, la thonine, le thon, la sardinelle, l'ethmalose, le chinchard, la carangue commune sont les espèces les plus incriminées. La plupart de ces espèces sont abondamment lavées et très épicées avant d'être cuisinées;

- toutes les manifestations d'allergie ou de pseudo-allergie alimentaire (lenteur de digestion, ballonnements, douleurs abdominales diffuses et vagues, urticaires, prurit, conjonctivite, oedème du visage, etc.) existent et leur fréquence augmente en hivernage lorsque le poisson est insuffisamment séché par manque de soleil.

Une recherche doit être entreprise pour approfondir ces enquêtes et déterminer l'efficacité des médicaments locaux utilisés pour guérir ces différentes manifestations.

Tableau 5

Evolution du pH et des teneurs en histidine et en histamine du kèthiakh artisanal et du kèthiakh préparé au dessiccateur solaire, à base d'ethmalose

	Braisage par terre			Braisage par fumoir		
	pH	Histamine mg/100 g	Histidine g/100 g MAT	pH	Histamine mg/100 g	Histidine g/100 g MAT
Séchage naturel						
Poisson frais	6,25	12,25	4,78	6,25	12,25	4,78
Poisson braisé	6,35	38,50	2,45	6,30	28,90	2,58
Fin ler jour de séchage	6,40	60,80	2,36	6,35	42,86	2,82
Fin 2e jour de séchage	6,50	89,82	2,78	6,35	50,06	2,98
Séchage solaire						
Poisson frais	6,05	7,40	5,10	6,10	6,80	5,05
Poisson braisé	6,10	17,80	2,90	6,05	9,90	2,86
Fin ler jour de séchage	6,20	20,20	3,20	6,15	11,85	2,95
Fin 2e jour de séchage	6,40	11,80	3,25	6,18	13,78	3,10

Tableau 6

Evolution des teneurs en histidine et en histamine du kèthiakh artisanal stocké de façon traditionnelle à Mbour et Joal

Origine	Espèces	Fin séchage naturel			Stockage 3 semaines		
		Humidité	Histamine mg/100 g	Histidine g/100 g MAT	Humidité	Histamine mg/100 g	Histidine g/100 g MAT
MBour	Sardinelle ronde	30 %	56	3,05	21 %	13,10	2,82
	Sardinelle plate	28 %	91	2,98	19 %	7,80	3,12
	Ethmalose	33 %	29	2,70	17 %	8,10	2,62
Joal	Sardinelle ronde	27 %	40	2,64	18 %	7,80	3,10
	Sardinelle plate	26 %	38	2,96	15 %	5,60	3,06
	Ethmalose	29 %	56	2,48	19 %	9,80	2,18

Tableau 7

Composition du kèthiakh en grammes pour 100 grammes de partie comestible (fabrication artisanale)

Espèces	Calories	Humidité	Protéines	Lipides	Cendres	ABVT
Sardinelle ronde[a/]	360	29	52,5	11,2	6,2	58
Sardinelle plate[b/]	368	27	58,4	5,6	5,9	90
Ethmalose[c/]	374	31	50,8	9,6	6,4	79

[a/] Sardinella aurita (yaboye meureug en Ouoloff)
[b/] Sardinella aeba (yaboye tass en Ouoloff)
[c/] Ethmalosa fimbriata (Cobo en Ouoloff)

Tableau 8

Aspects organoleptiques et commercialisation du kéthiakh[a]

Caractéristiques	Kéthiakh braisé-séché	Kéthiakh braisé au four
Coût de production	matière première 72-82 % consommations intermédiaires (bois, sel) 7-12 % main-d'oeuvre 9-14 %	matière première 76-83 % consommations intermédiaires (bois) 4- 8 % main-d'oeuvre 10-15 %
Aspect après séchage	jaune-noirâtre structure friable aliment à humidité intermédiaire entassé à même le sol ou sur les claies tas recouvert de plastique reséchage le jour	jaune-clair structure dure produit sec entassé sur les claies de séchage recouvert de plastique la nuit reséchage le jour
Pertes	émiettement apparence attaque dermestes et nécrobies attaque rats vols	émiettement apparence attaque dermestes et nécrobies - vols
Conditionnement	paniers de 60-80 kg problème emballage adéquat	cartons de 60-150 kg problème emballage adéquat
Prix de vente: en zones de prodution	au kilogramme FCFA 40 à 80 selon offre et demande	au kilogramme FCFA 100 à 180 selon offre et demande
hors zones de production	FCFA 100 à 250 selon offre, demande et localités	FCFA 200 à 350 selon offre, demande et localités
Zones d'écoulement	rurales et urbaines (comme sources de protéines animales dans les plats à base de céréales: riz, maïs, mil)	urbaines, rurales et exportation vers les pays voisins (Guinée, Guinée-Bissau, Mali) (comme source de protéines animales dans les plats à base de céréales)

[a] En Casamance: le braisage des ethmaloses et des sardinelles se fait sous vapeur dans les concessions avant séchage. C'est un produit à usage familial uniquement

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ANNEXE 1

Dérivés aminés des acides aminés par décarboxylation bactérienne

Bases aliphatiques

$$\text{Lysine} \xrightarrow[\text{Lysine décarboxylase}]{-CO_2} \text{pentaméthylènediamine ou cadavérine}$$

$$\text{Ornithine} \xrightarrow[\text{Ornithine décarboxylase}]{-CO_2} \text{tétraméthylènediamine ou putrescine}$$

Bases cycliques

$$\text{Histidine} \xrightarrow[\text{Histidine décarboxylase}]{-CO_2} \text{Histamine}$$

$$\text{Tryptophane} \xrightarrow[\text{Tryptophane décarboxylase}]{-CO_2} \text{Tryptamine}$$

$$\text{Tyrosine} \xrightarrow[\text{Tyrosine décarboxylase}]{-CO_2} \text{Tyramine}$$

ANNEXE 2

Intoxications histaminiques par ingestion de poissons

Certains auteurs (Boyer *et al.*, 1956; Ramel *et al.*, 1965) se sont intéressés aux teneurs d'histamine dans le poisson. Les résultats trouvés ont permis de dresser le tableau des teneurs suivant:

- 0 à 5 mg/100 g: sans danger;
- 5 à 10 mg/100 g: manifestations légères mais troubles bénins chez les personnes sensibles;
- 10 à 100 mg/100 g: toxique;
- de plus de 100 mg/100 g: très toxique.

Au dessus de 100 mg/100 g des accidents majeurs peuvent apparaître. Les manifestations surtout vasomotrices sont observées dans la demi-heure qui suit l'ingestion de l'aliment incriminé (thon par exemple). Elles sont caractérisées par:

- un état de malaise brutal avec une très forte céphalée;
- des palpitations cardiaques violentes (jusqu'à 150 pulsations/m);
- des étourdissements;
- une importante vaso-dilatation facio-cervicale.

Des douleurs abdominales sont parfois observées accompagnées de vomissements. L'évolution est habituellement favorable et les symptômes de l'intoxication disparaissent en quelques heures. Mais à haute dose, l'histamine peut causer un collapsus cardiaque.

Photo 1a Aspect du poisson braisé au sol

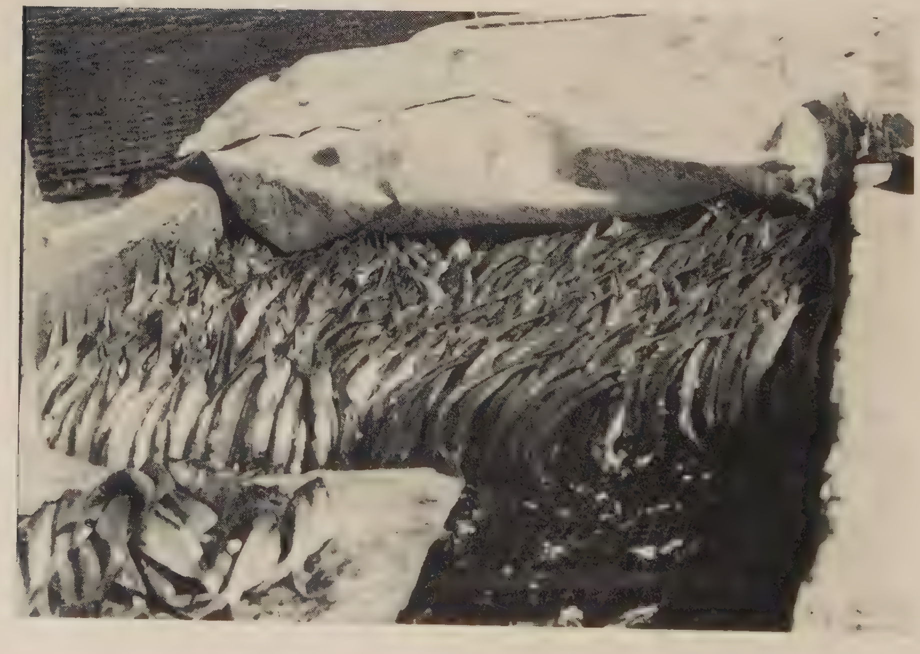

Photo 1b Aspect du poisson braisé au four en parpaings (Atelier de MBour)

Photo 2a Aspect du poisson braisé au sol après épluchage

Photo 2b Aspect du poisson braisé au four: épluchage

Photo 3a Aspect du poisson braisé: séchage naturel

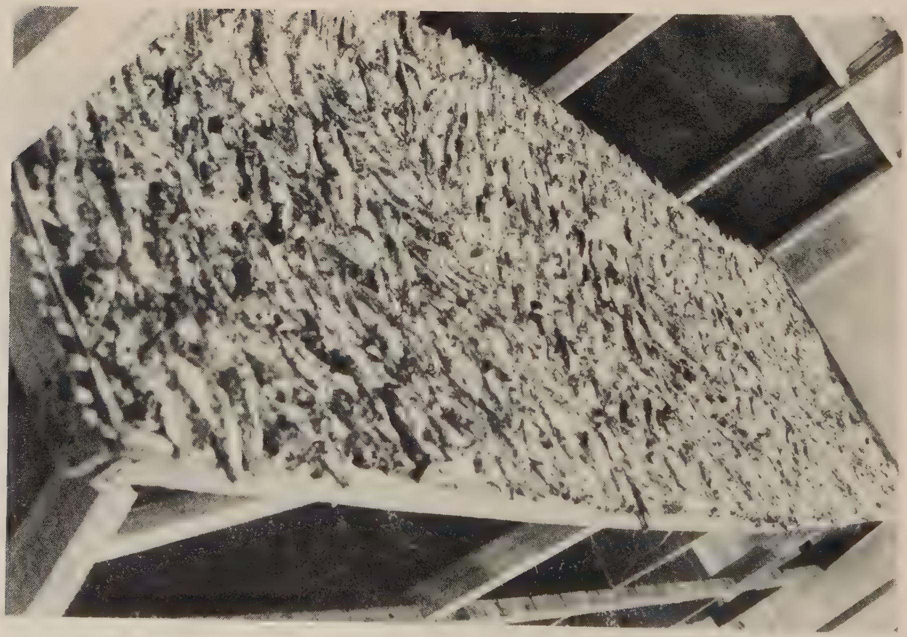

Photo 3b Aspect du poisson braisé: séchage au dessiccateur solaire (Atelier de MBour)

AN EXAMINATION OF SOLAR AND TRADITIONALLY DRIED FISH IN NIGERIA

by

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ABSTRACT

Catfish (*Chrysichthys nigrodigitatus*) and Tilapia species (*Tilapia zillii*) obtained from Nigerian fresh waters were either traditionally smoked (TS), traditionally solar dried (TD), oven dried (OD) or dried using a University of Ife designed and built solar dryer (ISD). A comparative cost analysis of the processes showed that the ISD product was the cheapest on a medium-term basis. Quality was determined by proximate composition, total amino acid, available lysine, fatty acid, nutritive value, polynuclear aromatic hydrocarbons, nucleotides and nucleotide-related products. Product acceptability was assessed by an untrained taste panel. Results obtained and the implications of the findings are discussed.

1. INTRODUCTION

As a source of animal protein, fish occupies a unique position in the diet of Africans. Since the technology of freezing and canning is expensive and beyond the resources of artisanal fisherman, traditional methods of preservation are normally employed. Fishes are preserved by two main methods, smoking and solar drying. The traditional smoking method widely used in most regions of Africa involves exposing the fish directly to burning wood which leaves heavy smoke deposits on the resulting product. In the solar drying techniques, fish is simply exposed to open sunlight where it may be infested by insects or windborne sand. While the fisherman preserves his catch for economic reasons, the consumer purchases the fish for its organoleptic qualities. Smoked or solar dried fish in modern Africa has become a delicacy and is a valued component of the menu. It is not surprising, therefore, that dried fish is the most important fish product in international fish trade in Africa. Thus, for example, smoked fish made in Gambia and Senegal are marketed in Liberia whereas large quantities of dried fish from Mali and Chad are marketed in Nigeria.

Consumption of fish preserved by these methods is high in Nigeria and may remain so for quite some time (3 kg *per caput* in 1980, and 9.9-11.1 kg *per caput* projected for 1985 (Lapido, Fabiyi and Fatunla, 1981)). Information has been very sparse on these traditional techniques. The aim of this study is to assess the economics and quality of traditionally smoked or solar dried fishes. This was compared to fish processed using a Fisher drying oven and a University of Ife designed and built solar dryer. The major freshwater species traditionally processed in Nigeria, catfish (e.g., *Chrysichthys nigrodigitatus*) and Tilapia (e.g., *Tilapia zillii*) were used.

2. MATERIALS AND METHODS

Sample treatment: fishes processed in the traditional manner were caught in the wild in various locations in Nigeria, placed ungutted in saturated brine for three minutes, and smoked (TS) or solar dried (TD) on site and transported to Ife.

Oven dried (OD) or Ife - solar dried (ISD) products were prepared from fish collected from fresh waters in Oyo State of Nigeria. The fish were soaked in saturated brine for three minutes and dried using a drying Fisher Drying oven (Model 60) or the Ife-solar dryer. Samples of fresh fish (FF) were transported live from various locations in Nigeria to Ife.

Traditional smoking techniques vary from group to group in Africa. The most popular method, which is placing fish on wire gauze in a wood fire kiln made of a steel drum, was simulated. The smoking time used was two hours (an average time used by local fishermen) and the carcass temperature at the end of smoking was 110°-120°C. The traditional solar drying time was 4-6 days in the open air as practised by Nigerian fishermen. This resulted in carcass temperature of 50°-60°C. Oven dried fish were subjected to 70°C for 48 hours. Fish prepared in the Ife-solar dryer were dried for 36 hours (six hours/day at temperatures of 60°-90°C). Fish of each species and treatment were placed together, ground finely and stored at -30°C for no longer than two weeks before analysis.

Moisture contents were determined in duplicate on 1 g samples from each treatment group and on 4 g from fresh fish according to AOAC (1980). Similarly, oil contents in duplicate 5 g samples from each treatment group and 10 g from fresh fish were determined by the method of Bligh and Dyer (1959). Crude protein contents were determined by the Kjedahl procedure as described by Eastoe and Courts (1963).

Amino Acid Analysis: total amino acid analysis was carried out on the samples after acid hydrolysis by refluxing for 24 hours under nitrogen using an LKB amino acid analyser as previously described (Afolabi and Oke, 1981). Available lysine was determined by the method of Booth (1971).

Fatty Acid Analysis: oil extraction was by the method of Bligh and Dyer (1959). Analysis of fatty acids was carried out by transesterification BF_3 methanol followed by gas chromatography using Hewlett Packard 5 880 gas chromatograph (FID) on a 25 m x 0.2 mm SP 1 000 flexible fused silica column, coupled to a splitless injection mode autosampler (1.2 µl per injection). The column temperature was between 140°-250°C at 3°C/min. The carrier gas was helium at a flow rate of 0.75 ml/min.

Polynuclear Aromatic Hydrocarbon (PNAH) Analysis: the PNAH fraction from 5 g of treated sample was extracted in quadruplicate and isolated as described by Mackie et al. (1980). Recovery efficiencies were estimated using fully deuterated anthracene (4.82 ng) and pyrene (11.1 ng) included as spikes in samples prior to extraction. The routine recovery efficiency determined in this laboratory was usually greater than 90% for the following PNAH standards: Ideno (1, 2, 3, -cd) -pyrene, Dibenz-(a, H)- anthracene, Benzo-(a)-pyrene, Benzo-(ghi)-perylene, 7, 12, Dimethyl anthracene, Benzo-(k)-fluoranthene, 9, 10, Dimethyl anthracene, Chrysene + Triphenylene, d10 anthracene and d10 pyrene.

The PNAH's were quantitatively analysed by Mass Spectroscopy. GC-MS analysis was carried out using a GC micromass 16F mass spectrometer equipped with a VG 2 250 data system. The mass spectrometer was coupled with a gas chromatography (Pye 104). A 25 m methyl silicone quartz capillary column (programmed from 100°C to 260°C at 3°C per minute) was used in the gas chromatograph. The mass spectrometer was operated in the electron impact and selective ion recording modes. Identification of PNAH was based mainly on direct comparison of mass spectrometer response to 37 PNAH standards.

Chrysene was measured with Triphenylene, since they gave rise to the same parent ion. The b, k, and j isomers of benzoflouranthene were estimated as a group using Benzo-(k)-flouranthene as standard. Similarly, dibenzanthracenes and C2 isomers of benzanthracene/phenanthrene have also been estimated as a group.

Nucleotide and Nucleotide Related Product Analysis: the method used was essentially that of Murray (private communication) using anion exchange High Performance Liquid Chromatography.

Materials: reference nucleotides, nucleotides and bases were obtained from Sigma Chemical Company.

Extraction Preparation: 20-g fish was homogenized with 40 ml ice cold 0.6 M Perchloric acid for 1 minute in an MSE homogeniser. After Buchner filtration into an ice chilled flask, 20 ml of the filtrate was adjusted to pH 7.04 with 5 M KOH. Extracts were held in an ice bath for 30 minutes and portions of the supernatant were removed from the precipitated.

Conditions of Separation: column 25 cm Partisil SAC 10 µ, 260 nm, 0.1 AUFS, 4 µl aliquots used for injection, eluate 0.04 M KH_2PO_4 containing 0.00187 M H_3PO_4 at ml/min. Recorder chart speed 1 cm/min., 10 nV FSD. A Water Model 6 000 pump coupled to a variable volume U6K valve injector was used for delivery of eluate buffer to the column. Detection of UV absorbing materials in the eluate was made using a Cecil 212 spectrometer filter with a 10 µl flow cell.

Nutritive Evaluation: the nutritive value was determined by animal assay technique using weanling litter mate rats of the Wistar strain from our animal colony. The technique used was the same as that described previously (Afolabi and Oke, 1981) in which treated and fresh fish were used as the main sources of protein. All fish samples were dried in an oven at 70°C for 24 hours.

Organoleptic Assessment by Taste Panel: organoleptic scores for taste, texture, flavour appearance and overall acceptability were evaluated at each tasting session by different panels of 400 consisting of persons from Ife University campus, not trained formally in sensory assessment.

The panel attended in groups of 10 and five randomly coded samples were presented to each member for assessment. The assessors described their opinions of the samples using a 5-point scale (1 = Dislike much; 2 = Dislike; 3 = Neither like nor dislike; 4 = Like; 5 = Like much) as previously described (Afolabi et al., 1981). The assessors were asked how much they were prepared to pay for samples of fish from each treatment group displayed to them after each tasting session.

Cost Analysis: cost analysis study was carried out in twelve locations in Nigeria (Ile-Ife, Ibadan, Lagos, Ilorin, Minna, Sokoto, Kano, Maiduguri, Enugu, Aba, Calabar, and Port Harcourt). A questionnaire was designed to investigate from fishmongers, processors and market women the types of fish they market or process, the cost of processing equipment, time required to process, capacity of equipment, how many sets of equipment a processor can handle, cost of maintenance per batch, life of equipment, value of equipment at the end of six months, number of times fish smoking or solar drying is done per day/week, cost of consumable batch and sale price of each piece of fish. Costing of labour was done by using a value of N 1.50/h, the average cost of unskilled labour in Nigeria. Sale price of OD and ISD product was obtained by using a mean of purchase values suggested by the organoleptic assessors.

3. RESULTS

Proximate Composition: the proximate composition of fresh (FF), traditionally smoked (TS), traditionally solar dried (TD), oven dried (OD), and Ife-solar dried (ISD) fish species used for the palatability trials is presented in Table 1. The data show that Chrysichthys nigrodigitatus and Tilapia zillii are similar in composition though C. nigrodigitatus contains significantly higher total lipid ($P < 0.01$). The crude protein, total lipid, total ash and crude fibre contents of the fish increase with decreasing moisture content. As shown in Figure 1 the extent of drying usually achieved using the moisture content as indicator is significantly greater in OD and ISD than TS and TD samples ($P < 0.01$). It appears the fatty C. nigrodigitatus is more difficult to dry because of the higher fat content than T. zillii.

Amino Acid Composition: Table 2 shows the amino acid composition of various fish groups. The amino acid patterns of all the processed fish species are similar. Table 3 revealed that all the fish species and treatment groups have high lysine content compared to whole hen's egg and other animal protein sources (Afolabi and Oke 1981, Mitchell and Block, 1946). However, there is a decrease in available lysine with processing. In general the order of available lysine is OD > ISD > TS > TD ($P < 0.05$).

Fatty Acid Composition: the fatty acid composition (Table 4) does not appear to show any systematic variation with fish species or treatment groups. There are, however, higher proportions of unsaturated fatty acids in OD and ISD than TS or TD, although not statistically significant.

Polynuclear Aromatic Hydrocarbon (PNAH) Composition: in view of limited space, the detailed concentrations of the 37 major PNAH analysed cannot be presented. However, the total PNAH, carcinogenic hydrocarbons (CCH), and mutagenic hydrocarbons (MTH) concentrations in the various fish groups are presented in Table 5. In all methods of preservation, TS products always have significantly higher values. TD and ISD have values greater than OD but lower than TS. The CCH and MTH concentrations in the smoked product are always four to ten times higher than in any of the other products ($P < 0.05$).

Nucleotides and Nucleotide Related Products Composition: the results of the nucleotide and nucleotide related products are presented in Table 6. No systematic variation in individual nucleotide content was observed. A pooled percentage of the total nucleotides (Table 7), however, shows the following relationships:

(a) ATP + ADP: TD > OD > ISD > TD

(b) AMP : OD > TD > ISD > TS

(c) IMP : TS > TD > OD > ISD

(d) INO : TS > ISD > OD > TD

(e) IHO : TD > ISD > OD > TS

Nutritive Evaluation: the results of the rat feeding trials are shown in Table 8. The data shows that all fish samples are of high nutritive value. All samples have superior Biological Value (BV), True Digestibility (TD), Net Protein Utilization (NPU), and Protein Efficiency Ratio (PER) to casein ($P < 0.01$), although they are not significantly different from each other.

Organoleptic Assessment by Taste Panel: Tables 9 and 10 summarize the taste panel results. From the results of the consumer panel, no systematic differences between fish treatments or between species could be discerned. Although no systematic differences were noticed on inspection of the pooled means, the medians of hedonic scores of organoleptic attributes showed quite obvious differences with fish treatments. Among the individual attributes, FF was always scored highest. The trend of scores, FF > TS > OD > ISD > TD, was maintained in the treatment groups for all quality attributes. Scores in general lay between 3.32 and 4.97 except for TD which was between 1.43 and 2.53.

Cost Analysis: information obtained from fish processors, fish-mongers, market women and taste panelists is presented in Table 11. Fish was always processed on an individual basis by most processors. As a basis for comparison, a time of 2 1/2 h required by an average fish processor to supervise a batch of smoked fish was used as the time necessary to process fish using other techniques, viz (TD, OD and ISD). In 2 1/2 h, fifteen batches, each, of TD, OD and ISD can be handled by a single processor. Also, the salvage value of the equipment (TD, OD, ISD) was determined at the end of six months, the average life of a traditional steel drum smoking kiln. In computing the cost analysis (Table 12), the following assumptions were made:, (a) a 50% depreciation for all equipment at the end of six months; (b) no taxes were paid by either the processors or retailers of the fish. This decision was reached because not all the fish processors or vendors pay taxes. Those who pay tax pay a paltry flat rate, which is mandatory whether they are gainfully employed or not. Table 12 shows that in six months of production, ISD would be the most profitable and TS the least. Also, C. nigrodigitatus attracts higher price than products from T. zillii.

4. DISCUSSION

Drying or smoking of fish for preservation has been with man since the evolution of settlement in communities (Steinberg, 1980) and still remains today the method of choice in traditional African society. The principal aim of fish processing is to reduce resource waste and enhance fish quality. However, with these traditional process techniques there are great problems in maintaining quality during and after processing. In this study, the quality changes and cost analysis of such traditionally preserved fish are examined.

Results obtained for proximate analysis and feeding trial experiments suggest that the nutritive value of fish samples is high and that the process conditions used resulted in products which have more proximate composition per unit weight of fish. However, the animal assay technique did not discriminate between the fish treatment groups and species. All samples have similar nutritive values.

Similarly, the results of the amino acid profiles of the various products suggest that there is no substantial loss in total amino acid during processing. However, the decrease in available lysine is clear evidence of damage to protein due to Maillard's reaction.

This reaction may be accelerated by heat, moisture, storage and processing. The high loss in TS may be due to the high heat of processing (Labuza, 1973) and the loss in TD largely due to biochemical and/or microbial deterioration during the relatively long drying time (4-6 days) (Ikeda, 1980). Comparing OD and ISD, drying at 70°C affects available lysine the least.

The fatty acid composition does not appear to change in any consistent direction with processing. However, there are higher proportions of unsaturated fatty acids in OD and ISD.

Total PNAH, CCH, and MTH concentrations in all the fish samples were dependent on the method of preservation ($P < 0.01$ for PNAH, $P < 0.05$ for CCH and MTH). Preserving fish at a low temperature (70°C for 48 h) in a closed environment (OD) appears to reduce the occurrence of polycyclic hydrocarbons. The lower drying temperature (50°-60°C) used in TD which was expected to give lower levels of PNAH had however, the opposite effect ($P < 0.05$). This could be due to exposure of the fish in the open while drying. Also, contaminants from the environment may have contributed to the elevated levels (Blumer and Youngblood, 1975). The higher values obtained with ISD fish may be due to the higher drying temperature encountered (60°-90°C) or contaminants from the environment because the Ife-solar dryer was not sealed. PNAH concentrations in TS fish, which were higher than any other method, could be due to the high temperature (110°-120°C) of smoking which might generate more pyrolytic products from both wood and fish (Masuda and Kuratsune, 1967).

In the fish muscle, adenosine nucleotides constitute more than 90% of the total nucleotides and the main component is ATP (Ikeda, 1980). The principal post mortem course of ATP decomposition in fish (Tarr, 1966; Eskin, Henderson and Townsend, 1977) is $ATP \rightarrow ADP \rightarrow IMP \rightarrow INO \rightarrow HX$. In general, the reactions $ATP \rightarrow IMP$ take place at a relatively early stage after death. In this period the reactions $IMP \rightarrow INO \rightarrow HX$ occur more slowly than those in the sequence $ATP \rightarrow IMP$. Accordingly, IMP is readily accumulated in the fish in the early stage after death. INO and HX concentrations increased with lapse of time or with decrease in freshness. The significantly higher amounts of IMP and of lower HX in TS (Table 7) indicate that the smoked fish was the freshest at the end of processing, whereas TD is the least fresh.

Organoleptic Assessment by Taste Panel: the overall acceptability scores obtained using untrained taste panels should closely relate to the overall preference of the consumer for the samples. An inspection of the remarks made by individual members of the panel showed that smoked fish was the most preferred alternative to fresh fish in Nigeria. It appears the traditionally solar dried fish was least acceptable to the sensory assessors because it had some off flavour, pebbles and sometimes dust.

Cost analysis of the process techniques considered in this study revealed (Table 12) that ISD process has the highest mean net income. Although a higher net income was computed for the C. nigrodigitatus OD product than the ISD product, the OD process is more capital intensive. Also, the technology involved in the OD process is too expensive for Nigeria and most African countries. The disadvantage of TS and TD is that they are labour intensive. The seemingly high cost of consumables for TS is expected to increase in the near future with the increasing depletion of forests and expanding desert in Africa. The advantages of ISD is its relatively low running cost and free and abundant solar power in Africa.

5. CONCLUSIONS

In conclusion, although the freshest and most acceptable fish product next to FF is TS, because it contained the lowest amount of HX, it is highly contaminated with potential toxicants such as PNAH. Whereas, the exact toxicological implications of PNAH are not clear, the levels reported here in the TS fish should be of concern. This is especially true in the light of reports which implicate PNAH in a number of carcinomas of the gastrointestinal tracts (Lo and Sandi, 1978). Since the TS fish examined in this study are considered to be lightly smoked, heavily smoked fish may contain even higher concentrations of carcinogenic and mutagenic PNAH. Most traditionally smoked fish in the local market are exposed to smoke for longer periods than used here. In order to increase the shelf life of smoked fish, fish vendors may re-smoke the fish many times until it is sold, thus increasing the occurrence PNAH compounds (Masuda and Kuratsune, 1967). Therefore, higher levels of these potentially toxic PNAH can be expected in fish sold in local markets than reported here.

An immediate suggestion that arises from this study is that various governments in Africa, especially Nigeria, should consider the establishment of maximum allowable concentrations of PNAH in smoked fish. Values reported here are higher than levels found in UK and most EEC countries (McGill et al., 1981). The use of an oven or solar dryier for the preservation of food should be encouraged. The disadvantage of TD (the cheapest to run), is the heavy sand contamination, disease carrying insect infestation, and low chemical and organoleptic quality. Oven drying is capital intensive, requires an electric power supply and adequate equipment maintenance. Therefore, it is impractical in the villages where most of the fish processing is done. In the villages there is no electric power supply, no expertise for equipment maintenance, and the cost of purchase is prohibitive to the local fisherman. The nutritional, chemical and organoleptic qualities of ISD are comparable to OD. Sun is abundant in Africa and the Ife-solar dryer requires neither electric power supply nor any consumables. It provides a hygienic environment, may be constructed locally and is highly profitable to run. Smoke flavour, free of potential toxicants, can be cheaply introduced to improve organoleptic attributes.

The practical implications of this work is that the preservation of fish using the Ife-solar (an Ife-designed and built solar dryer) provides a cheap and profitable alternative to smoking and traditional solar drying.

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Table 1

Proximate composition of Fresh (FF), Traditionally Smoked (TS), Traditionally Solar Dried (TD), Oven Dried (OD), Ife-Solar Dried (ISD), fish used for organoleptic studies. (Values are means of 10 determinations. Values in parenthesis are standard deviation of means)

Fish species			Proximate	Composition (%)		
	Treatment	Moisture	Crude protein	Total lipid	Total ash	Fibre (Modified acid) detergent
C. nigrodigitatus	FF	76.19(7.39)	17.61(6.71)	6.44(1.91)	0.83(0.94)	0.13(0.06)
	TS	57.37(5.92)	24.68(3.82)	6.39(1.97)	1.21(0.42)	0.24(0.05)
	TD	52.61(8.01)	24.56(3.02)	7.62(1.65)	1.90(0.91)	0.28(0.16)
	OD	12.96(4.96)	75.62(6.21)	24.17(1.12)	2.61(1.10)	0.6(0.18)
	ISD	12.21(5.62)	76.43(9.13)	21.43(1.43)	3.79(0.31)	0.6(0.14)
T. zillii	FF	77.56(0.56)	18.88(6.80)	2.75(1.27)	0.95(0.17)	0.10(0.04)
	TS	48.31(2.49)	30.94(7.10)	4.48(1.27)	1.35(0.18)	0.26(0.14)
	TD	45.68(5.62)	37.52(2.34)	4.84(1.54)	1.81(0.84)	0.37(0.12)
	OD	10.87(2.90)	76.71(34.19)	19.62(1.65)	3.78(0.28)	0.71(0.14)
	ISD	11.63(2.90)	78.25(27.38)	19.34(1.76)	3.33(0.10)	0.88(0.61)

Table 2

Amino acid composition of Traditionally (TS), Traditionally Solar Dried (TD), Oven Dried (OD), Ife-Solar Dried (ISD), fish. (Values are arithmetic means of duplicate determinations)

Fish species	Treat-ment	Amino acids (g/100 g protein)																	
		Asp.	Thr.	Ser.	Glu.	Pro.	Gly.	Ala.	Val.	Cys.	Met.	Ile.	Leu.	Tyr.	Phe.	NH_3	Lys.	His.	Arg.
C.nigrodigitatus	TS	10.85	3.21	3.27	15.13	2.25	7.11	6.03	4.17	0.29	3.91	4.18	7.81	3.52	3.15	5.82	13.11	2.66	4.61
	TD	10.24	3.62	3.68	15.16	3.18	7.25	6.63	4.71	0.22	3.71	5.27	7.10	3.01	3.17	5.12	12.15	2.88	5.31
	OD	10.16	3.02	3.01	15.71	2.25	7.88	6.36	4.22	0.42	3.72	4.81	8.18	3.91	3.81	5.21	13.91	2.37	5.19
	ISD	10.31	3.52	3.75	15.52	2.01	7.32	6.32	4.17	0.23	3.66	4.61	8.71	3.50	3.31	5.55	13.11	2.11	5.91
T. zillii	TS	11.30	3.55	3.70	16.36	3.17	5.88	6.53	5.00	0.50	3.10	5.82	8.46	3.02	3.44	6.12	11.37	3.11	5.36
	TD	10.10	3.60	3.10	17.14	3.46	5.91	6.67	5.10	0.58	3.26	5.26	8.11	3.19	3.01	5.52	11.96	3.24	5.01
	OD	12.42	4.15	3.59	17.54	3.56	5.56	6.54	5.81	0.63	3.71	5.56	8.67	3.50	4.67	6.29	14.93	4.38	5.92
	ISD	11.07	3.74	3.24	15.64	3.48	6.56	6.08	5.21	0.59	3.35	5.06	7.86	3.17	3.76	5.76	13.68	3.86	5.48

Table 3

Available lysine in Traditionally Smoked (TS), Traditionally solar Dried (TD), Oven Dried (OD), Ife-solar Dried (ISD), fish. (Values are arithmetic means of 4 determinations)

Fish species	Treatment	Total lysine (g/100 g protein)	Available lysine (g/100 g protein)	% available
C. nigrodigitatus	TS	12.67	10.11	79.79
	TD	12.30	8.33	67.72
	OD	14.38	13.89	96.59
	ISD	13.91	12.63	90.80
T. zillii	TS	11.37	8.25	74.9
	TD	11.96	8.29	69.3
	OD	14.93	14.26	95.5
	ISD	13.68	12.09	88.4

Table 4

Fatty acid composition of Traditionally Smoked (TS), Traditionally Solar Dried (TD), Oven Dried (OD), Ife-Solar Dried (ISD), fish.
(Values are means of duplicate determinations)

Fish species	*C. nigrodigitatus*				*T. zillii*			
Treatment	TS	TD	OD	ISD	TS	TD	OD	ISD
Fatty acid								
C14:0	2.4	2.9	3.2	2.9	4.1	2.2	2.7	2.8
C15:0	2.6	2.1	2.9	2.7	2.2	2.2	1.4	2.3
C16:0	22.9	22.3	22.1	22.5	23.8	22.5	19.6	22.8
C16:1	6.1	6.4	6.1	6.1	5.7	9.0	4.5	5.2
C17:0	2.0	2.1	2.8	2.6	1.9	2.1	2.0	2.3
C18:0	8.7	7.1	7.2	8.1	6.2	7.5	8.3	7.6
C18:1	15.3	15.2	15.5	15.4	14.9	11.8	16.5	16.3
C18:2	4.7	3.2	3.5	3.5	6.0	6.5	7.5	6.7
C18:3	4.0	4.0	4.7	4.9	2.0	2.0	4.5	3.1
C18:4	0.8	0.6	0.8	0.8	1.2	0.9	0.8	1.1
C20:4	3.2	3.3	3.7	3.6	3.8	3.8	3.9	3.8
C20:5	3.2	3.2	3.4	3.1	tr	0.6	0.7	0.7
C22:5	0.7	0.8	0.7	0.7	1.7	1.8	1.8	1.9
C22:6	3.0	3.2	3.9	3.4	3.8	2.6	2.9	3.6
Minor components	20.4	23.6	19.5	19.7	22.7	24.5	22.9	19.8
% saturates	38.6	36.5	38.2	38.8	38.2	36.5	34.0	37.8
% mono-unsaturates	21.4	21.6	21.6	21.5	20.6	20.8	21.0	21.5
% polyunsaturates	19.6	18.4	20.7	20.0	18.5	18.2	22.1	20.9
Total % unsaturates	41.0	40.0	42.3	41.5	39.1	39.0	43.1	42.4

Table 5

Total Polynuclear Aromatic Hydrocarbons (PNAH), carcinogens and mutagens content of Traditionally Smoked (TS), Traditionally solar Dried (TD), Oven Dried (OD), and Ife-Solar Dried (ISD) fish. (Values are expressed as ng/g fish dry wt.)

Fish species	Treatment	Total PNAH[a]	Carcinogen[b]	Mutagen[c]
C.nigrodigitatus	TS	1 084.36	226.47	264.72
	TD	457.80	61.89	60.42
	OD	265.46	21.64	22.01
	ISD	371.69	52.95	43.16
T. zillii	TS	1 995.61	478.01	590.02
	TD	369.32	28.76	24.31
	OD	322.28	22.12	22.36
	ISD	382.16	44.04	41.83

a/ PNAH analysed here include: Napthalene, 2-methyl napthalene, 1-methyl napthalene, C-2-isomer of napthalene, C4-isomer of napthalene, flourene, methyl flourene, Benzo (1, 2), flourene, Benzo (2, 3), flourene, anthracene, Methyl anthracene, C2-isomer of anthracene, Benz (a) anthracene, Dibenzanthracene, pyrene, C1-isomer of pyrene, cyclopentapyrene, Benzo (e) pyrene, Benzo (a) pyrene, indenopyrene, Phenanthrene, cyclo-pentaphenanthrene. Benz (c) phenanthrene, Dibenzo-thiophene, C1-isomer of Dibenzothiophene, C2-isomer of dibenzothiophene, Biphenyls, Acenaphthylene, Benz-acenaphthylene, Chrysene + Triphenylene, C1-isomer of Chrysene, C2-isomer of Chrysene, Flouranthene, Benzoflouranthene, Perylene, Benzo-perylene, and $C_{18}H_{10}$ (unknown).

b/ Carcinogens include: Phenanthrene, Benz (a) anthracene, chrysene + triphenylene, Benzoflouranthenes, Benzo (c) pyrene, Benzo (a) pyrene, Indenopyrene, Benzoperylene, Dibenzanthracene.

c/ Mutagens include: Phenanthrene, anthracene, flouranthene, pyrene, benz (a) anthracene, Chrysene + Triphenylene, Benzo (a) pyrene (Lo and Sandi, 1978; Poncelet *et al.*, 1978)

Table 6

Nucleotides and related products content of Traditionally Smoked (TS), Traditionally Solar Dried (TD), Oven Dried (OD), Ife-Solar Dried (ISD) fish. (Values are means of 10 determinations. Values in parentheses are % of total nucleotides)

Species	Treatment	Nucleotide and related products (µmoles/g fish)					
		ATP+ADP[a/]	AMP[b/]	IMP[c/]	INO[d/]	HX[e/]	Total nucleotide
C. nigrodigitatus	TS	0.25(13.37)	0.02 (1.07)	0.56(29.95)	0.71(37.97)	0.33(17.65)	1.87
	TD	0.08 (2.35)	0.36(10.56)	0.75(21.99)	1.35(39.59)	0.87(25.51)	3.41
	OD	0.37 (7.07)	2.14(40.92)	0.74(14.15)	1.32(25.24)	0.66(12.62)	5.23
	ISD	0.12 (7.27)	0.05 (3.03)	0.26(15.75)	0.79(47.88)	0.43(26.06)	1.65
T. zillii	TS	0.27(15.6)	0.08 (4.6)	0.47(27.1)	0.61(35.3)	0.30(17.3)	1.73
	TD	0.02 (1.9)	0.02 (1.9)	0.15(14.4)	0.25(24.0)	0.60(57.7)	1.04
	OD	0.30(10.8)	0.13 (4.7)	0.58(20.9)	1.08(39.0)	0.68(24.5)	2.77
	ISD	0.13(10.1)	0.08 (6.2)	0.12 (9.3)	0.31(24.0)	0.65(50.4)	1.29

[a/] Adenosine Triphosphate

[b/] Adenosine Diphosphate

[c/] Adenosine Monophosphate

[d/] Inosine

[e/] Hypoxanthine

Table 7

Pooled mean percentages of nucleotides and related product composition of Traditionally Smoked (TS), Traditionally Solar Dried (TD), Oven Dried (OD), and Ife-Solar Dried (ISD)

Fish treatment	Pooled mean % nucleotides and related products				
	ATP + ADP	AMP	IMP	INO	HX
TS	14.49	1.42	28.53	36.64	17.48
TD	2.13	6.23	18.20	29.80	41.61
OD	8.94	22.81	17.53	32.12	18.56
ISD	8.69	4.62	12.53	35.94	38.23

ATP = Adenosine Triphosphate

ADP = Adenosine Diphosphate

AMP = Adenosine Monophosphate

IMP = Inosine Monophosphate

INO = Inosine

HX = Hypoxanthine

Table 8

Nutritive value of fresh (FF), Traditionally Smoked (TS), Traditionally Solar Dried (TD), Oven Dried (OD), Ife-Solar Dried (ISD), fish used for organoleptic studies. (Values are means of 8 replicates. Values in parentheses are standard deviation of means)

Protein source	Treatment	BV	TD	NPU	PER
Casein		56.10(0.2)	98.71(2.0)	55.37	1.63(0.1)
C. nigrodigitatus	FF	96.85(4.1)	94.38(3.5)	91.41	2.8(0.6)
	TS	79.81(4.4)	91.32(1.6)	72.88	2.3(0.9)
	TD	82.68(6.1)	95.47(1.7)	78.93	2.1(0.4)
	OD	94.16(2.8)	96.59(1.2)	90.95	2.7(0.7)
	ISD	88.65(1.4)	95.89(3.6)	85.01	2.3(0.2)
T. zillii	FF	85.72(1.2)	96.64(9.1)	82.84	2.7(0.5)
	TS	81.35(3.4)	92.41(1.5)	75.18	2.6(0.7)
	TD	72.63(1.2)	91.16(1.5)	66.21	2.1(0.6)
	OD	95.68(2.4)	95.23(3.1)	91.11	2.8(0.4)
	ISD	91.45(1.7)	94.34(2.3)	86.27	2.6(0.9)

Table 9

Medians of Hedonic Scores of Taste, Flavour, Texture, Appearance, and Overall Acceptability of Fresh (FF), Traditionally Smoked (TS), Traditionally Solar Dried (TD), Ife-Solar Dried (ISD) fish

Fish species	Treatment	Organoleptic Attributes Scored				
		Taste	Flavour	Texture	Appearance	Acceptability
C. nigrodigitatus	FF	4.92	4.87	4.85	4.82	4.98
	TS	4.54	4.96	4.37	4.92	4.81
	TD	3.02	1.65	2.44	1.42	1.37
	OD	4.40	3.52	3.72	4.64	4.26
	ISD	4.24	3.43	3.28	4.07	4.54
T. zillii	FF	4.98	4.87	4.94	4.87	4.96
	TS	4.97	4.32	4.46	4.50	4.72
	TD	2.04	1.73	2.28	1.61	1.48
	OD	3.85	3.59	4.37	4.16	4.44
	ISD	3.69	3.21	3.95	3.47	4.08

Table 10

Pooled Means of Median of Hedonic Scores of Taste, Flavour, Appearance and Overall Acceptability of Fresh (FF), Traditionally Smoked (TS), Traditionally Solar Dried (TD), Oven Dried (OD), Ife-Solar Dried (ISD), fish

Treatment	Pooled Means of Medians of Organoleptic Attributes Scored				
	Taste	Flavour	Texture	Appearance	Overall acceptability
FF	4.95	4.87	4.90	4.85	4.97
TS	4.76	4.64	4.42	4.71	4.77
TD	2.53	1.69	2.36	1.52	1.43
OD	4.13	3.56	4.05	4.40	4.35
ISD	3.97	3.32	3.62	3.77	4.31

Table 11

Information obtained from Fish processors, fishmongers, market women and, taste panelists during this study

Item	Process technique			
	TS	TD	OD	ISD
Cost of equipment	N40.00	N2.00	N2 500.00	N120.00
Time required per round of processing	2.5 hrs	4-5 days	48 hrs	6 days
Number of equipments that a processor can handle per round of processing	1	15	15	15
Number of fishes (115-400 g wet weight) per equipment per round of processing	20	20	20	20
Total number of fishes that can be processed by one processor per round of processing	20	300	300	300
Total time required for supervision by one processor per round of processing	2.5 hrs	3 hrs/day = 12-18 hrs	0.5 hr/day = 1 hr	0.5 hr/day = 3 hrs
Number of rounds of processing possible in six months (7 days a week, 4 weeks a month)	2 times/day, 5 days a week = 240	Average = 5 days per round of processing = 34	At 48 hrs per round of processing = 84	At 6 days per round of processing = 28
Labour hours required per person in six months	600	408 - 612	84	84
Cost of labour in six months at N1.50 per hour	N900.00	N612.00-N918.00	N126.00	N126.00
Consumables	Firewood	-	Electricity	-

Table 11 (continued)

Item	Process technique			
	TS	TD	OD	ISD
Cost of consumables per round of processing	N4.00	-	N8.00	-
Cost of consumables in six months	N2 400.00	-	N672.00	-
Maintenance requirement of equipment in six months	Equipment due for replacement in six months	-	N200.00 per equipment	N1.00 per equipment
Cost of maintenance of equipment in six months	-	-	N3 000.00	N15.00
Salvage value of each equipment at the end of six months	N0.00	At 50% depreciation =N1.00	At 50% depreciation =N1 250.00	At 50% depreciation N60.00
Total salvage value of equipment at the end of six months	N0.00	N15.00	N18 750.00	N900.00
Sale price of one piece of processed fish *T. zillii* *C. nigrodigitatus*	N1.00 N1.50	N0.50 N0.80	N1.00 N1.50	N1.00 N1.50
Total number of fishes that can be processed in six months by one processor	4 800	10 200	25 200	8 400
Expected income from sale of fish in six months by one processor *T. zillii* *C. nigrodigitatus*	N4 800.00 N7 200.00	N5 100.00 N8 160.00	N25 200.00 N37 800.00	N8 400.00 N12 600.00

Table 12

Cost analysis of Traditional Smoking (TS), Traditional Solar Drying (TD), Oven Drying (OD) and Ife-Solar Drying (ISD) techniques
(Assumptions: 1.50% depreciation for equipment in six months. 2. No taxes)

Item	Process technique			
	TS	TD	OD	ISD
Expenditure				
Cost of equipment	N 40.00	N30.00	N37 500.00	N1 800.00
Labour	N900.00	N612.00-N918.00	N126.00	N126.00
Maintenance	N0.00	N0.00	N3 000.00	N15.00
Consumables	N2 400.00	-	N672.00	-
Total	N3 340.00	N642.00-N948.00	N41 298.00	N1 941.00
Income				
Salvage value of equipment	N0.00	N15.00	N18 750.00	N900.00
Expected sale of fish in six months				
T. zillii	N4 800.00	N5 100.00	N25 200.00	N8 400.00
C. nigrodigitatus	N7 200.00	N8 160.00	N37 800.00	N12 600.00
Total *T. zillii*	N4 800.00	N5 115.00	N43 950.00	N9 300.00
C. nigrodigitatus	N7 200.00	N8 175.00	N56 550.00	N13 500.00
Net income (Income-expenditure)				
T. zillii	N1 460.00	N4 167.00-N4 473.00	N2 652.00	N7 359.00
C. nigrodigitatus	N3 860.00	N7 227.00-N7 533.00	N15 252.00	N11 559.00
Mean net income for all types of fishes	N2 660.00	N3 697.00-N6 003.00	N8 952.00	N9 459.00

EFFECT OF SALTING ON THE STORAGE AND QUALITY CHARACTERISTICS OF SMOKED FILLETS OF THE CROAKER (*Pseudotolithus typus*) CAUGHT IN NIGERIAN WATERS

by

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ABSTRACT

Eight lots of fish fillets were dipped in saturated brine solutions for 0, 10, 20, 30, 40, 50, 60, and 90 min and the samples salted for 0, 30, 60, and 90 min were then smoked. Each lot was then divided into two; one half was packaged in heat sealed polythene bags, the other half was left unpackaged. Both halves were stored at ambient (27°-30°C) temperature.

Salting time affected percent weight loss and shrinkage (in length). While percent moisture content and extract release volume decreased with salting time, salt uptake and extractable protein nitrogen increased with salting time. Gross protein and total lipid fractions increased slightly as salting time increased while the pH was only slightly affected by salting time. Salting completely suppressed microbial growth in smoked fish. During the storage of smoked fillets, salting appeared to have no effect on mold growth after four weeks storage while salting suppressed the growth of *Staphylococcus aureus* and coliforms. However, salting made the smoked fish less organoleptically acceptable than unsalted fish. Unpackaged salted smoked fish absorbed moisture from the atmosphere and appeared soggy, thus seriously affecting sensory attributes. Salting appeared to have little effect on the nutritional composition of smoked fish.

Salting alone may not prevent incipient spoilage in smoked fish. However, salting accompanied by protective packaging and antimycotic agents may be effective against incipient spoilage in smoked fish.

1. INTRODUCTION

Fish preservation by salting has been existing for a considerable part of mankind's history. Salting of fish has also been done in conjunction with other preservation methods like sundrying, smoke drying, smoking and canning. However, the approach to salting practices has been mostly empirical and practical (Del Valle and Nickerson, 1967).

Some effects in the recent past had been put into elucidating the basic mechanism involved in preservation of fish by salting. Ingram and Kitchell (1967) in their review on the use of salt as a preservative for foods highlighted its use in inhibiting objectionable putrefaction and dangerous microorganisms, and those which it does not inhibit are more or less unobjectionable. They reported that the effect of salt is similar to that of drying; low concentrations of salt stimulate the growth of microorganisms whereas higher concentrations inhibit it.

Scott (1953, 1957) introduced the concept of water activity as a quantitative approach to the understanding of the influence of water on microbial proliferation. Salt crystals act as "drying agents" by reducing the amount of free water available to microorganisms without reducing water content. Also, it was observed that some halophilic bacteria are able to survive high salt concentrations because they need sodium chloride to maintain the stability of their cell wall (Ingram and Kitchell, 1967).

Research into the effect of salt on the physico-chemical characteristics of fish had shown that fish muscle immersed in brine will either gain or lose water depending upon the brine concentration and temperature. Duerr and Dyer (1952) reported that myosin fractions of fish muscle proteins were denatured when a critical salt concentration of approximately 8-10% was reached, and that the rapid denaturation was accompanied by a sudden increase in salt uptake and moisture loss. This is in agreement with the work of Hamm (1960) who also reported that if muscle is immersed in brine and allowed to equilibrate in salt, one or two changes may occur. At low and intermediate salt concentrations, water is transferred from the brine to the muscle and the muscle swells. At concentrations beyond a certain point, water is transferred from the muscle to the brine, in which case if the concentration is high enough the muscle becomes "salted out". Del Valle and Nickerson (1967) working with swordfish (Xiphias gladius) and examining the equilibrium consideration in salting, reported that the salt concentration in fish muscle at equilibrium always increased with increasing brine concentration. Although the variation may not be linear, Crean (1961) found an inverse linear correlation between the salt and water contents expressed as percentages on a wet basis for the range.

Some workers have also carried out investigations on the effect of salting on the development of pests on fish. Amos (1968) made laboratory observations on the developments of Dermestes frischii on sea water fish while Mushi and Chiang (1974) studied D. maculatus on fresh water fish. They found that high salt concentrations in fish inhibited development of the beetles. Also Osuji (1975) working with fish meal, reported depressed larval development in D. maculatus and Necrobia rufipes in salted fish; larval mortality was total in D. maculatus at salt concentrations of 9.2% and 10.2%.

Aitken et al. (1967) studying the effects of drying, salting and high temperatures on the nutritive value of dried cod reported that neither brining nor dry salting have any influence on the nutritive value of dried cod.

In this study, we have examined the pattern of salt uptake by fillets of croaker and have subjected the fillets containing varying levels of salt to smoking with a view to determine the effects of such treatments on the course of microbial deterioration and on the quality of the ensuing product. Another objective was to use salt as a means of controlling or reducing insect infestation in smoked fish in the tropics, particularly Nigerian, thereby reducing the loss by such organisms.

Croaker (P. typus) caught by R/V FEDERAL ARGONAUT off Lagos coastal waters with Granton nets were washed with clean sea water before chilling in ice for 4 h prior to landing. The fish were then immediately sorted, washed and filleted manually with the skin-on. Fillets of uniform sizes were distributed into eight lots and salted for 0, 10, 20, 30, 40, 50, 60, and 90 min in saturated aqueous salt solution (26.5%). Samples were taken after different salting times. Then the fillets were drained and smoked for about 10 h in a NIOMR kiln. The smoked fillets were stored at ambient temperature after which samples were taken. The smoked fillets were again divided into 2 lots per each salting time. One lot was packaged in heat sealed polythene bags while the other lots were left unpackaged in open trays. Both lots were stored at ambient (27°-30°C) temperature.

After salting, measurements in triplicates were made of weight, length and changes in width, pH, extractable protein nitrogen, extract release volume, salt uptake and moisture content. After 0, 30, 60, and 90 min salting, samples were analysed for percentage gross protein, total lipid content and microbial quality. After smoking, the samples salted for 0, 30, 60, and 90 min before smoking were assessed for:

(a) sensory evaluation: they were scored for texture, flavour, appearance and overall acceptability;

(b) microbial quality assessment: aerobic total viable counts, mold count, most probable number (M.PN.) counts of coliforms and extreme halophiles;

(c) moisture content;

(d) thiobarbituric acid number for measurement of rancidity;

(e) salt concentration;

(f) nutritional composition (total lipid and protein).

At two-week intervals samples of the packaged and unpackaged smoked fish salted for 0, 30, 60, and 90 min were analysed for:

(a) sensory properties;

(b) moisture content;

(c) microbial quality (as enumerated above);

(d) thiobarbituric acid number.

Weight before and after salting were measured using a top loading Mettler balance. The length and width measurements were made with a ruler before and after salting.

Salt uptake determinations were made according to the Association of Official Agricultural Chemists (AOAC, 1960) silver nitrate titrimetric method. From this, the concentration of salt in tissue fluid of the fish was calculated using the standard formula:

$$C = \frac{100S}{S + W}$$

where C = salt concentration
S = determined salt uptake in %
W = moisture content in %

Moisture content determinations were carried out using the direct distillation method of Dean and Stark (1920).

pH was measured by homogenising 2 g of fish in 20 ml distilled water for 1 min and taking the pH immediately using a PYE Unicam pH meter.

Extract Release Volume (ERV) determinations were made by weighing 15 g minced samples into the 100 ml vortex breaker of an MSE homogeniser. The mince was extracted with a solution containing 50 ml 0.2 M KH_2PO_4 and 3.72 ml 0.2 M NaOH diluted to 200 ml with distilled water, the pH being adjusted to 5.8 before blending for 2 min. The homogenate was filtered using a filter paper (Whatman No, 1;18.5 cm diameter). The volume of filtrate collected in 15 min was measured as ERV.

Extractable Protein Nitrogen (EPN) determinations were made using the method of Dyer, French and Snow (1950).

Total lipid determinations were done by the method of Bligh and Dyer (1959).

Protein determinations were done by the microkjeldahl method using a factor of 6.25. (AOAC, 1960).

Microbial counts were restricted to microorganisms reported by Harrigan and McCance (1976) as being important in marine fish products from spoilage and public health standpoints. The organisms counted in salted fish were aerobic total viable count, coagulase *Staphylococcus aureus* (extreme halophiles, MPN of coliforms and *Vibrio parahaemolyticus*). The counts were made according to the methods of Harrigan and McCance (1976).

State of rancidity was recorded as thiobarbituric acid value which was determined according to the method of Tarladgis *et al.* (1960).

The smoked fish samples were presented to a panel to score for appearance, overall acceptability, flavour and texture on a nine point hedonic scale. The panellists who were semitrained were selected from the members of staff of the Nigerian Institute for Oceanography and Marine Research. The panellists were familiar with salted and smoked fish. An instrument laboratory was used for the test with only one panellist allowed in at a time. Eight panellists were used for the evaluation of smoked fish at day 0 while 12 panellists were used for evaluation of smoked fish after four weeks of storage.

2. RESULTS AND DISCUSSION

Table 1 shows that small croaker fillets dipped in saturated brine absorbed salt from the brine losing water which probably led to contraction in length of the muscle as shown in Table 2.

While the trend in the salt uptake showed an increase with salting time, the trend in % shrinkage and % moisture were somewhat inconsistent. It appeared that there was a slight "swelling" in the muscle after 30 min of salting as shown in Table 2. However, there was no corresponding increase in moisture content (Table 1). These results tend to suggest that in fish salted pre-rigor there are other factors influencing physico-chemical characteristics apart from protein denaturation. This view is buttressed by Table 3 which shows an increase in protein solubilisation as salting time increases. Duerr and Dyer (1952) reported a decline of protein solubilisation as salting time increased in post-rigor cod muscle. It was also observed that there was a decrease in ERV as salting time increased until after 50 min when there was a slight and temporary break in the trend. This suggests an increase in the water binding capacity of the muscle as salting time increased with a temporary break after 50 min. This may be explained by the work of Duerr and Dyer (1952) that when muscle is placed in brine with a salt concentration of about 2 to 5%, myosin swells very strongly and the water in the tissues becomes more firmly bound to the myosin micelles. Furthermore, salting time of up to 60 min had little effect on the pH of croaker muscle brined pre-rigor.

It would appear that salting for up to 90 min had only a slight effect on percent gross protein in salted croaker muscle (Table 4). On the other hand there was an increase in percent total lipid

Table 1

Effect of salting time on salt concentration, salt uptake and moisture content of croaker fillet

Salting time (min)	Salt uptake (%)	Salt concentration (%)	Moisture (%)
0	0.04 ± 0.04	0.05	79.64 ± 3.14
10	3.78 ± 0.011	4.87	73.87 ± 1.63
20	5.47 ± 0.078	6.79	75.02 ± 2.19
30	6.12 ± 0.075	7.83	72.14 ± 99
40	6.60 ± 0.13	8.04	75.48 ± 1.55
50	7.15 ± 0.08	9.21	70.49 ± 2.06
60	7.67 ± 0.49	10.08	68.43 ± 2.05

Determinations were made on triplicate samples

Table 2

Effect of salting time on shrinkage in length and weight loss of croaker fillet

Salting time (min)	Shrinkage in length (%)	Weight loss (%)
0	0	0
10	0.33 ± 0.96	1.28 ± 0.62
20	2.55 ± 0.56	2.50 ± 0.74
30	4.82 ± 1.59	2.64 ± 1.15
40	2.87 ± 2.11	3.86 ± 0.36
50	1.63 ± 0.97	3.65 ± 0.84
60	2.27 ± 1.5	3.85 ± 0.56

Determinations were made on triplicate samples

content as salting time progressed. This may be due to removal of moisture from the muscle matrix thereby leading to an apparent increase in the total lipid fraction.

There was an indication that there were no viable Vibrio parahaemolyticus in croaker muscle used for this work as inoculated plates of TCBS cholera medium showed no growth after incubation for 48 h at 37°C. Table 5 shows that an increase in salting time led to a reduction in microbial population of salted fish. It appeared that salting was very effective in controlling growth of coliforms in croaker muscle (Fig. 1). Salting for just 30 min achieved a reduction of about 2 log cycles in the MPN count which is lower than the suggested standard of 100 organisms/gm of muscle for good bacteriological quality fish (Harrigan and McCance, 1976). The results also showed that salting inhibits the growth of other microorganisms normally encountered in fish, with the inhibition increasing as salting time progressed.

There were no marked differences in the overall acceptability and texture whereas there were significant differences in the flavour of the samples. Table 6 shows that the unsalted fish had better flavour ($P < 0.05$) than fish salted for 60 and 90 min before smoking. It appears that 30 min is the maximum salting period if the flavour of the fish is to be conserved. All panellists reported a deposit of salt crystals on and colour loss in the salted fish samples. In salted samples ground ready for laboratory analysis, it appears that the longer the salting time the lighter the colour. This could be due to protein solubilisation which occurs progressively when fish is salted.

Table 3

Effect of salting time on pH, extract release volume and extractable protein nitrogen of croaker fillet

Salting time (min)	pH	Extract release volume (ml)	Extractable protein nitrogen (%)
0	6.80 ± 0.1	51.00 ± 0.14	0.03 ± 0.002
10	6.73 ± 0.7	42.00 ± 17.5	2.56 ± 0.18
20	6.88 ± 0.03	37.30 ± 0.06	3.70 ± 0.32
30	6.74 ± 0.04	22.00 ± 18.15	3.47 ± 0.16
40	6.80 ± 0.04	18.66 ± 8.33	3.89 ± 0.2
50	6.78 ± 0.03	30.30 ± 4.93	3.99 ± 0.27
60	6.73 ± 0.03	29.00 ± 2.65	3.42 ± 0.42

Determinations were made on triplicate samples

Table 4

Means total lipid and protein salted fish

Salting time (min)	% lipid fraction (wet basis)	% protein (NX 6.25) (wet basis)
0	1.45 ± 0.014	16.1 ± 0.025
30	2.4 ± 0.014	15.9 ± 0.05
60	3.1 ± 0.014	16.0 ± 0.225
90	1.8 ± 0.028	15.8 ± 0.014

Determinations were made on duplicate samples

Myoglobin, a protein and a major pigment in fish muscle, might also become salt soluble and might be lost to the brine. The bleaching action of chloride ions could also contribute to the loss in fish muscle colour. The unsalted products were given the highest scores for texture and flavour. However, fish salted for 60 min was rated highly for overall acceptability (Table 6).

The effect of salting time on the microbial population of smoked fish is reported in Fig. 2. The actual microbial counts are recorded in Table 7. The effect of long exposure of fish samples to high temperature and bactericidal effects of smoked deposits in the kiln should greatly reduce the number of microorganisms after smoking. Hence, the microbial growth should be through re-contamination during cooling of the fish before samples for laboratory analysis were taken. However, as illustrated in Fig. 2, there was no growth on salted fish samples. The unsalted fish samples sustained good microbial growth.

Table 8 shows that the means of water content for salted products were higher than those of unsalted products with a decrease in the means as salting time increases. This corresponds to an increase in mean values for salt concentration in fish as salting time increased. Hygroscopic salt crystals in the salted fish samples may have absorbed moisture from the environment during the cooling of smoked fish products. This may be responsible for the higher moisture content as salting increases may be due to the gradual loss of water binding capacity of the protein as denaturation of the protein progresses during salting. This loss of water binding ability might have affected the dehydration pattern of the fish during hot smoking (at a temperature of about 100°C).

Table 9 shows low levels of malonaldehyde in the fish products, which means no appreciable oxidative rancidity took place during drying and smoking. Table 9 also shows a fall in total lipid content and protein content of the salted fish products when compared with unsalted ones. This may be explained by the fact that the salt crystals in the salted fish products will necessarily reduce the percentages of the other components of the fish. There could also have been a loss of the lipid and protein components of the fish during the smoking process.

Table 5

Mean counts of microorganisms in salted fish

Salting time	Aerobic TVC[a/]		Coagulase + *Staphylococcus aureus* count		Most probable number count of coliforms		Extreme Halophile count	
	Count/g	Log_{10} of count	Count/g	Log_{10} of count	Count/g	Log_{10} of count	Count/g	Log_{10} of count
0	1.83×10^5	5.26	1.04×10^5	5.02	280	2.45	3.5×10^4	4.54
30	1.31×10^5	5.12	9.6×10^4	4.98	5	0.69	1.8×10^4	4.25
60	1.2×10^5	5.08	5.6×10^4	4.75	16	1.2	9.8×10^3	3.99
90	5×10^4	4.69	2.66×10^4	4.42	2	0.3	1.30×10^4	4.11

[a/] TVC: Total Viable Count

Plates of TCBS cholera medium showed no growth at 37°C after 48 h

Table 6

Mean scores of sensory quality attributes
of salted and smoked fish

Salting time (min)	Overall acceptability	Texture	Flavour
0	5.6	5.9	6.75a
30	4.75	4.9	3.75ab
60	5.4	4.6	3.63bc
90	4.6	4.5	3.15bc

Means within the column for flavour followed by the same letter are not significant different by Tukey Test ($P < 0.05$)

Table 7

Mean counts of micro-organisms on salted and smoked fish

Salting time	Aerobic total viable count		Coagulase + Staphylococcus aureus count		Most probable number count of coliforms		Mold count	
	Count/g	$\log_{10}$ of count	Count/g	$\log_{10}$ of count	Count/g	$\log_{10}$ of count	Count/g	$\log_{10}$ of count
0	32×10^5	6.5	1.44×10^5	5.16	1.6×10^4	4.204	4.5×10^5	5.65
30	-	-	-	-	2	0.301	-	-

Table 8

Mean values for moisture content and salt concentration in salted and smoked fish fillets

Salting time (min)	% moisture content dry basis	% salt concentration dry basis
0	11.2 + 4.37	1.6 ± 0.29
30	29.2 ± 2.87	21.1 ± 0.24
60	19.2 ± 2.52	28.98 ± 0.15
90	14.4 ± 4.62	29.4 ± 0.4

Table 9

Mean values for mg of malonaldehyde per 1 000 g of fish,
% lipid and % protein of salted and smoked fish fillets

Salting time (min)	% lipid (dry matter basis)	Malonaldehyde (mg per 1 000 g of fish)	% protein (dry matter basis)
0	11.22 ± 1.2	1.6 ± 0.067	77.8 ± 1.4
30	6.2 ± 0.56	1.9 ± 0.044	67.2 ± 1.65
60	7.1 ± 0.85	1.5 ± 0.086	59.8 ± 1.5
90	7.4 ± 0.80	1.4 ± 0.016	57.4 ± 1.95

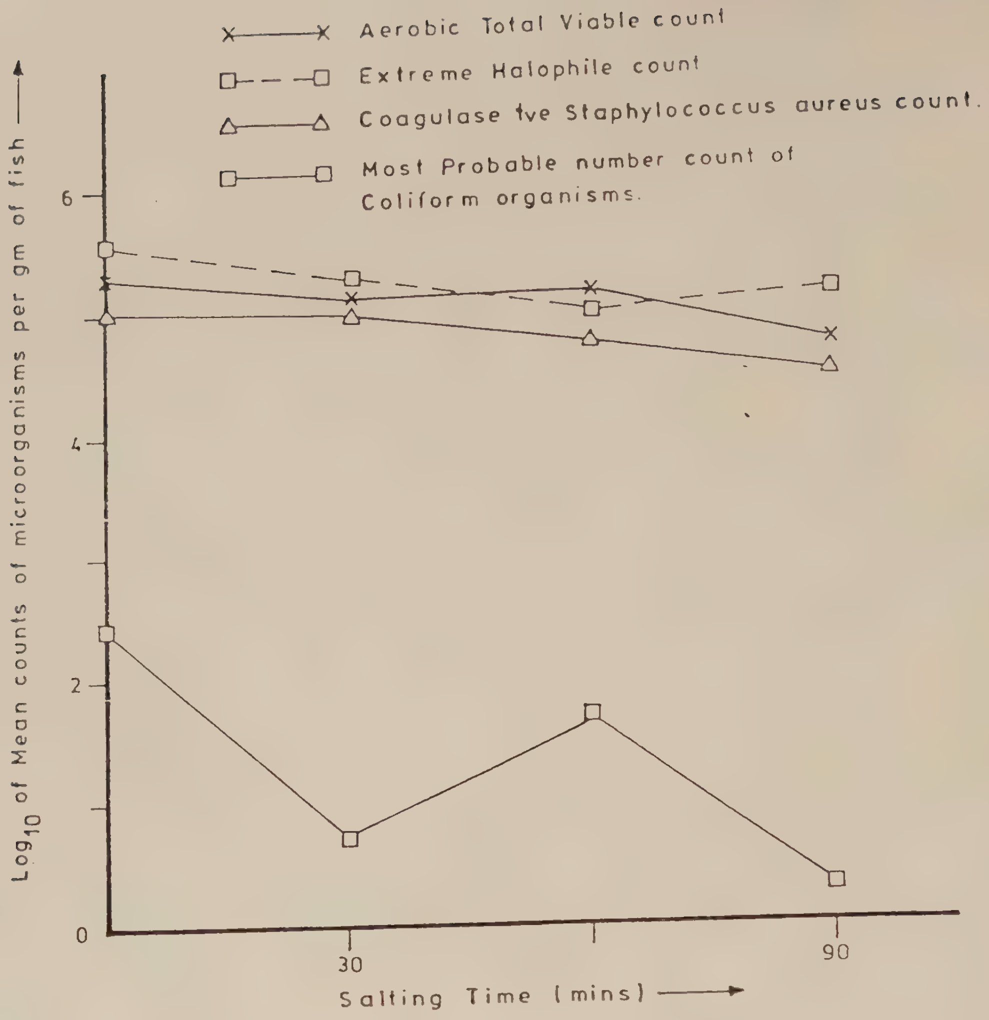

Figure 1 Effect of salting time on the microbial population of salted fish fillets

The effect of salting was coupled with packaging to study the effect of salting on packaged and unpackaged fish samples. Moisture contents of the unpackaged products are presented in Table 10. There was a sharp increase in moisture content of the unpackaged samples during storage.

The high level of moisture in salted unpackaged samples which may have been as a result of the salt absorbing moisture from the environment made the salted fish products soggy. This could have contributed to low scores in the appearance and overall acceptability of the salted samples after 48 days (Table 13). The samples salted for 90 min looked the most unpleasant and were judged lowest in appearance and overall acceptability (Table 13). The sogginess, however, did not seem to affect the texture of the samples. As shown in Table 13 the mean scores for texture as ordered did not follow the order for other attributes. This suggests that the water is absorbed onto the salt crystals on the surface of the fish without penetrating the fish muscle matrix. Also, it was observed that there was a slight increase in the moisture content of packaged fish with longer salting periods during storage (Table 11). However, the level is lower than observed for the unpackaged fish. This suggests that the packaging material (polythene) afforded some barrier against moisture. This is important from the standpoint of storage stability of the smoked fish products as the packing may increase shelf-life.

Mean scores of sensory attributes of salted, smoked fish fillets are presented in Table 12. There were no significant differences in overall acceptability and texture between salted and unsalted smoked fish. However, there were significant differences in flavour between unsalted and fish fillet salted for more than 30 min before smoking. This may be due to the high salt levels in the smoked fish samples.

Mean scores of the sensory attributes of salted, smoked fish fillets after four weeks of storage are presented in Table 13. There were significantly differences in all quality attributes evaluated.

Table 10

Effect of salting time on the moisture content
of unpackaged salted and smoked fish during storage

Salting time (min)	% moisture content (dry basis)		
	Day 0	24 days	48 days
0	11.1	21.2	25
30	22.7	43.9	62.6
60	19.4	44.9	66.6
90	14.3	49.3	66.6

Determinations were made for triplicate samples

Table 11

Effect of salting on the moisture content of
packaged smoked fish during storage

Salting time (min)	% moisture content (dry basis)		
	Day 0	24 days	48 days
0	11.1	14.5	17.6
30	22.7	23.9	25.0
60	10.4	20.5	21.2
90	14.3	19.9	21.2

Determinations were made on triplicate samples

Table 12

Effect of salting time on the sensory attributes of smoked fish fillets

Salting time (min)	Overall acceptability	Texture	Flavour
0	5.63	5.88	5.75a
30	4.75	4.88	4.00a
60	5.37	4.63	3.6 bc
90	4.63	4.50	3.1 bc

Means within the same column followed by the same letter are not significantly different by Tukey's Test ($P < 0.05$)

The unsalted samples had higher scores and were of significantly better quality than the salted ones for all attributes evaluated ($P < 0.05$). While the unsalted, packaged samples were rated slightly better than the unsalted and unpackaged samples, the unsalted, packaged samples were, however, not significantly different in all attributes from the unsalted, unpackaged samples. The texture of the unsalted fish was better than that of the salted fish. Judges commented on the presence of dead insects on the salted (unpackaged) samples. It is possible that the high salt level killed the insects that came into contact with the fish. However, the dead insects made the products look unpleasant. The unsalted samples were also infested by live insects. However, the insects did not seem to have done much damage to the fish. The packaged samples did not have infestation of any sort discernible, indicating that packaging might be desirable to prevent insect damage in stored smoked fish.

Tables 14 and 15 show that oxidative rancidity has not set in to any extent even after 4 weeks of storage. This probably suggests that the flavour scores for fish samples were mainly affected by the level of salt in the fish (Table 13) as unsalted samples had significantly better flavour scores than the salted samples ($P < 0.05$). Length of soaking in brine did not seem to have consistently affected the malonaldehyde content of the smoked fish.

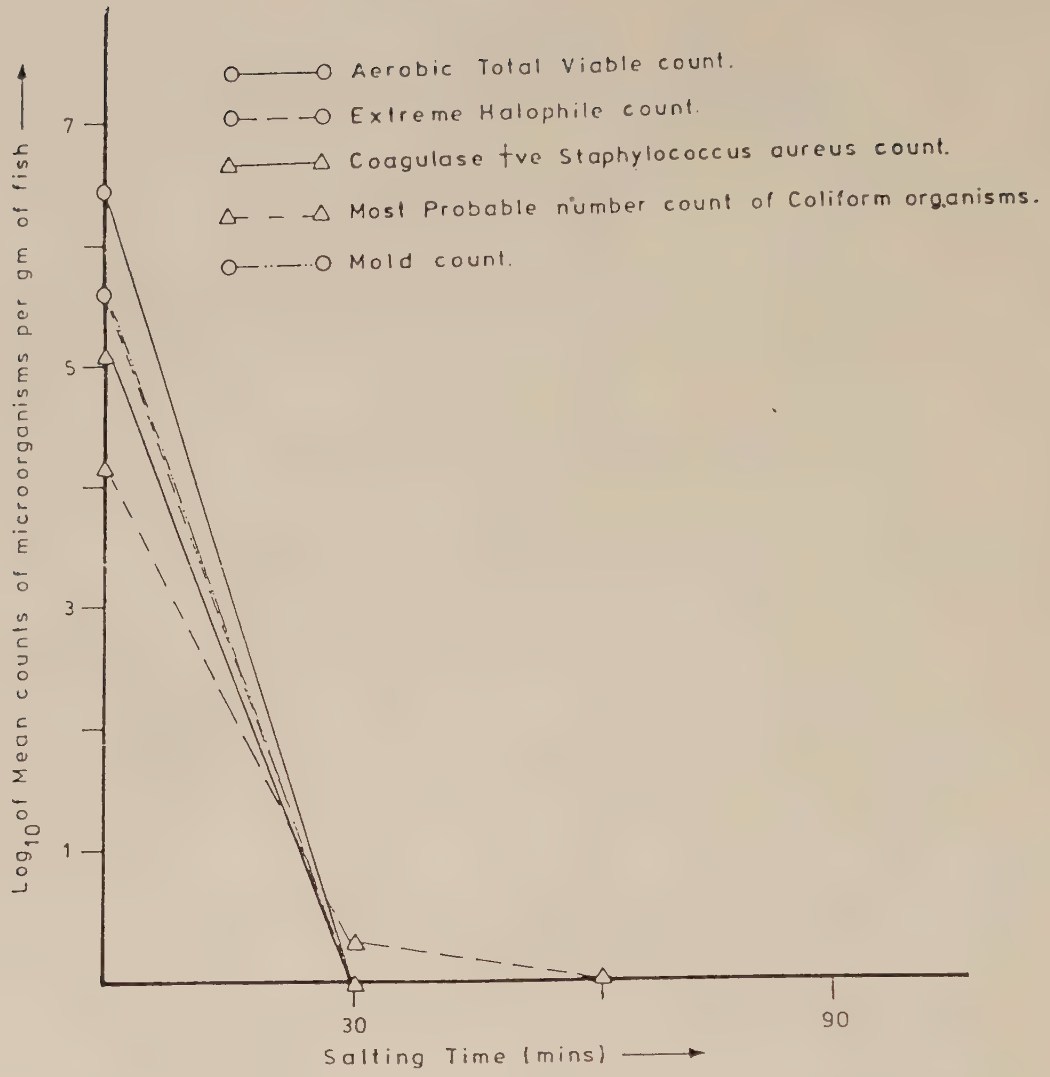

Figure 2 Effect of salting on the microbial population of smoked fish fillets

Table 13

Mean scores of sensory attributes of salted and smoked fish after 4 weeks of storage

Salting time (min)	Appearance	Overall acceptability	Texture	Flavour
Unpackaged				
0	6.4 a	6.3 a	6.25a	6.25a
30	4.98bc	4.6 b	4.67b	3.92bc
60	4.08cd	3.75bc	4.75b	3.83bc
90	4.08cd	3.2 c	4.9 b	2.92d
Packaged				
0	6.75a	6.75a	6.33a	6.66a
30	5.25b	4.5 b	5.5 ab	4.25b
60	4.25bc	3.6 bc	4.67b	3.2 cd
90	3.75c	3.75bc	5.08b	3.3 bc

Means within the same column followed by the same letter are not significantly different by Tukey's Test ($P < 0.05$)

Table 14

Mean malonaldehyde contents of unpackaged salted and smoked fish during storage

Salting time (min)	mg of malonaldehyde per 1 000 g of fish		
	Day 0	After 14 days	After 28 days
0	1.6	1.75	1.9
30	1.9	1.95	1.8
60	1.5	1.3	0.9
90	1.4	1.5	1.7

Determinations were made on triplicate samples

Table 15

Malonaldehyde contents of packaged salted and smoked fish during storage

Salting time (min)	mg of malonaldehyde per 1 000 g of fish		
	Day 0	After 14 days	After 28 days
0	1.6	2.1	2.3
30	1.9	1.85	1.3
60	1.5	1.6	1.45
90	1.4	1.6	1.8

Determinations were made on triplicate samples

Fig. 3 shows that salting alone does not inhibit mold growth in smoked fish during storage. However, salting effectively controlled the growth of other microorganisms especially coliform organisms which were totally suppressed. Analysis shows that unsalted fish samples have total viable counts higher (Table 16) than the $1x10^5$/g standard suggested by Harrigan and McCance (1976). Salting times of 60 and 90 min kept the growth of coagulase +ve Staphylococcus aureus within the 200 organisms per g count standard suggested by these authors, whereas salting for 30 min supported a high growth. These results support the generally believed idea that water activity and not moisture content appears to be the important factor in the suppression of microbial growth. Microbial growth was controlled to an extent regardless of high moisture content. The high salt content reduces the available free water for microbial growth thereby reducing the water activity. Extreme halophiles were completely suppressed. This may be due to the activity of competing organisms especially mold which were present in high numbers.

Fig. 4 shows that mold growth was completely absent in unpackaged samples of fish salted for 90 min whereas fish salted for 30 and 60 min recorded lower mold counts after four weeks of storage. Extreme halophiles recorded a decrease in number as salting time increases beyond 30 min. The samples salted for 90 min sustained no mold growth and no coliform growth and recorded the lowest counts of Staphylococcus aureus and total viable counts. The samples salted for 60 min also had counts of these organisms lower than those of fish salted for 30 min but higher than those fish salted for 90 min. Thus, samples salted for 90 min have the lowest tendency for microbial spoilage. Comparing Table 16 and 17, it was observed that unsalted, unpackaged samples recorded lower counts during storage than unsalted, packaged samples. This may be due to contamination of the smoked fish by the packing material or by handlers during heat sealing.

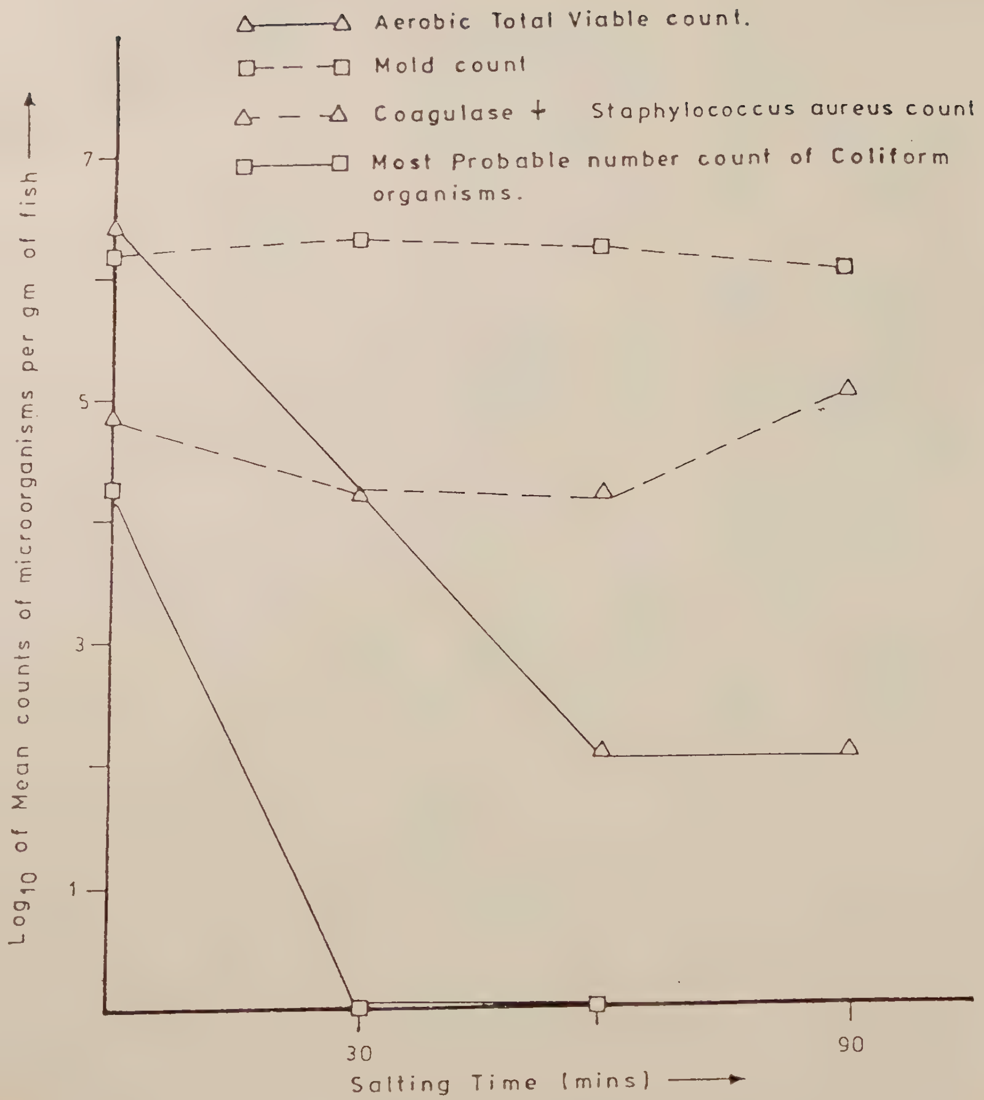

Figure 3 Effects of storage on microbial population of packaged smoked fish (After 4 weeks of storage)

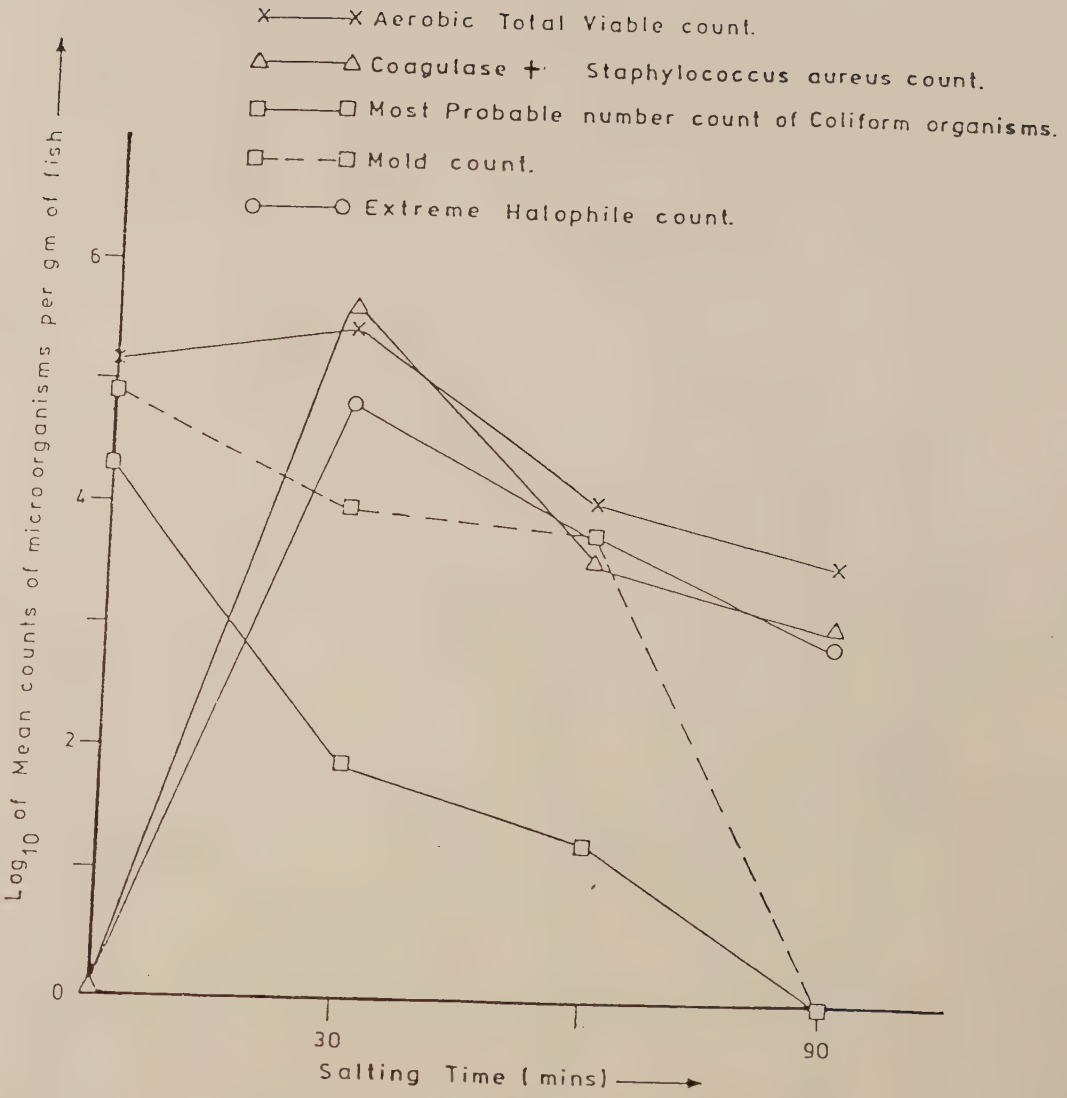

Figure 4 Effects of salting on the microbial population of unpackaged stored smoked fish fillets (After 4 weeks storage)

Table 16

Mean counts of salted, smoked fillets (unpackaged) after 4 weeks of storage

Salting time	Aerobic total viable count		Coagulase + Staphylococcus aureus		Most probable number count of coliforms		Mold count		Extreme halophile count	
	Count/g	Log_{10} of count	Count/g	Log_{10} of count	Count/g	Log_{10} of count	Count/g	Log_{10} of count	Count/g	Log_{10} of count
0	$1.48x10^5$	5.17	-	-	$2x10^4$	4.30	$8.1x10^4$	4.91	-	-
30	$3.2x10^5$	5.51	$4.8x10^5$	5.68	80	1.9	$1.00x10^4$	4.00	$7.6x10^4$	4.88
60	$1.55x10^4$	4.19	$4.5x10^3$	3.65	20	1.3	$7x10^3$	3.85	$2x10^3$	3.3
90	$4x10^3$	3.60	$1.5.10^3$	3.176	-	-	-	-	$1x10^3$	3.3

Table 17

Mean counts of microorganisms on salted, packaged smoked fish fillets after 4 weeks of storage

Salting time	Aerobic total viable count		Coagulase + Staphylococcus aureus		Most probable number count of coliforms		Mold count		Extreme halophile count	
	Count/g	Log_{10} of count	Count/g	Log_{10} of count	Count/g	Log_{10} of count	Count/g	Log_{10} of count	Count/g	Log_{10} of count
0	$2.73x10^6$	6.44	$7x10^4$	4.85	$1.8x10^4$	4.26	$1.6x10^6$	6.20	-	-
30	$1.7x10^4$	4.23	$1.65x10^4$	4.22	-	-	$2.0x10^6$	6.30	-	-
60	$1.45x10^4$	4.16	$1x10^2$	2	-	-	$1.62x10^6$	6.21	-	-
90	$1.01x10^5$	5.00	$1x10^2$	2	-	-	$1.05x10^6$	6.02	-	-

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TRIGGER FISH (Balistes spp.) PROCESSING INDUSTRY AT ELMINA (A FISHING VILLAGE IN CENTRAL REGION OF GHANA)

by

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ABSTRACT

Trigger fish falls within the Balistes group of fish whose name refers to the fact that the bones of the upper jaw are fused together. They are distinguished by the external feature of non-overlapping or open scales. The species landed in Elmina and other parts of Ghana has no scales and the body is covered with a very tough skin. It is of grey or dull grey colour interspersed with bluish spots at the back and has a characteristic smell.

At Elmina, trigger fish is always salted and sun dried to preserve it on commercial scale. Drying after salting makes it easy to peel off the tough skin and the salt also improves the taste.

Studies have been carried out on the traditional processing of trigger fish at Elmina. Proximate composition of samples from various processing centres is also provided. Recent studies indicate a growing trend in the trigger fish processing industry, both at Elmina and other fishing villages in Ghana.

1. INTRODUCTION

Various methods of salting fish have been reported. Van Veen (1953) reported on the salting of fish in Southeast Asia. Murray (1970) reported on how salting of cod by pickling and klondyking is carried out in Britain. Slaczka (1971) also describes various salting methods used in Poland. Very little information, however, is available in the literature on methods used in salting fish in Ghana even though a lot of fish salting is carried out. This report, therefore, is aimed at putting on record the traditional processing of trigger fish at Elmina, in particular, and Ghana, in general.

2. MATERIALS AND METHODS

This report is based on analysis of answers given by the trigger fish processors and on observation of all the activities involved in salting.

3. RESULTS AND DISCUSSIONS

In Ghana, trigger fish (see Figure 1) is harvested by canoe and inshore fishing. The use of trigger fish as a source of human food, and also personal source of income for fishermen and processors at Elmina and probably other parts of Ghana, has a recent history. Records from the Fisheries Division of the Ministry of Agriculture, Ghana, indicate that fishermen started landing appreciable quantities of fish only as recently as 1971. Prior to this period, no use was made of this species of fish. In fact those inadvertently caught were either thrown back to the sea or left to rot at the beach. The table below indicates trigger fish production in Ghana in 1978-82.

Table 1

Trigger fish production (in t)

	1978	1979	1980	1981	1982
Canoe	5 561.3	10 159.4	5 667.5	5 371.5	4 045.6
Inshore	2 777.7	2 577.1	2 154.6	112.2	2 365.7
Total	8 338.0	12 736.5	7 822.1	5 483.7	6 411.3

Source: Fisheries Research Unit, Tema, Ghana

The processing industry was started in 1971/72 by three women processors who claim to be the pioneers of the trigger fish business; others followed suit in 1972/73. A few women at that time accepted the trigger fish inadvertently caught for household consumption after it had been salted. Gradually the use of fish spread into many households, and surpluses over household requirement were bartered for other foodstuffs, mainly cassava, plantain and vegetables. From the barter stage, the salted fish appeared on the open market and slowly gained consumer acceptance. Incidentally, production of other fish like Sardinella spp. and mackerel dropped drastically around this time. Today, trigger fish is ranked among those species of fish having great economic importance and potential in Ghana.

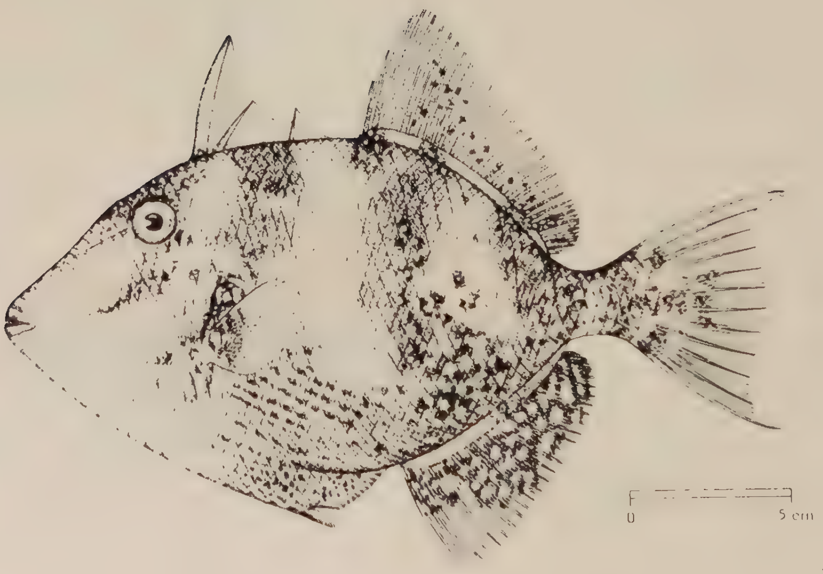

Figure 1 Trigger fish (Balistes capriscus)

4. TRADITIONAL METHOD OF SALTING TRIGGER FISH AT ELMINA

The processing of trigger fish is carried out only by women. Fresh fish is bought at the landing beach in basinfuls; a basin being the unit measure in the trade. A basin contains between 250 and 375 single fish, depending on the size of fish and size of landing that day. Thus, basins are fuller than usual when heavy landings are made. The basinfuls of fish are transported to the processing sites where they are gutted by young boys for a fee. The salting sites are either located close to the houses or else at some distance from the houses close to the beach. An open space is used communally for drying by processors, but salting is done individually under sheds.

Crude solar salt, which is available in sufficient quantities and at sufficiently low cost to enable the fish processor to recover expenses involved, is used. Gutted and washed fish are salted by the dry-salting method by either rubbing in salt in a basin before it is packed tightly or the fish and salt are placed in alternate layers in a container. This is followed by pickling, but the fish is not packed in air-tight containers. The pickle or brine formed is used to salt two or more subsequent batches of fish with the addition of marginal quantities of salt until the scent of pickle becomes intolerable.

Originally, wooden, pigfeet barrels were used, but due to the unavailability of barrels, containers like plastic bowls and barrels are also used. Some processors have constructed rectangular concrete troughs of the following average measurements: length 220 cm; width 148 cm; height 70 cm; thickness 10 cm. The quantity of salt used varies within wide limits, but a very rough ratio is about 4:1, (fish:salt). The fish is left to stand in salt overnight. The next day the fish is removed, washed and orderly arranged to dry in the sun on straws, polythene sheets or old fishing nets spread on the ground. The fish is turned during the drying process. On a sunny day, drying lasts one day. Where drying has to be continued for more than one day, the fish is taken indoors overnight and spread out again the following morning. Below are values obtained for the proximate composition of fresh and salted and dried trigger fish.

Table 2

	Moisture %	Protein %	Fat %	Ash %	Salt %	Iron % mg	Phosphorus % mg	Calcium % mg
Fresh trigger fish	79.1	19.4	0.3	1.4	-	-	-	-
Salted and dried trigger fish	40.5	37.8	1.6	18.2	16.8	3.0	581.0	348.0

Salted and dried trigger fish is hard, salty and slightly fermented. The tough, almost leathery coat or skin of the fish also makes it extremely resistant to pressure.

5. STORAGE

The salted and dried fish are packed tightly for storage in round, traditional mud ovens at the processing sites and covered with polythene sheets. For transportation to markets, fish are repacked into specially sewn, large jute bags. A well-processed fish will keep for months because of the salt level, tough skin and the fact that trigger fish is non-fatty and rather bony.

6. MARKETING

Elmina acts as a wholesale market for processed trigger fish and it is from this source that the bulk of it is supplied to many urban markets in Ghana. During packaging for sale, fish are sorted into grades according to size and quality. Wholesale fish is sold in batches of 100 single pieces. Fish are then retailed in the open market single, especially in hinterland areas, north of the country.

7. USE OF TRIGGER FISH

In Ghana, after many years, most people have acquired the taste for salted fish. Therefore, the use of salted, dried trigger fish in the diet did not impose any problem. It is usually used in the preparation of stews and soups. Before it is used for cooking, the tough skin is peeled by hand and the fish then soaked in water for some time. The fish is highly scented and is said to impart a nice flavour to stews and soups, even though it is used primarily as a protein source and not as a condiment.

8. CONCLUSION

An insight into the traditional processing industry of trigger fish at Elmina has been provided. Trigger fish is landed in other parts along the West African coast, but the industry is not yet on an advanced scale, as is practised in Ghana. It is hoped that this information will help stimulate interest in its use in other parts of the world.

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UTILIZATION OF THE NILE PERCH (Lates niloticus) IN LAKE VICTORIA

by

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ABSTRACT

Nile Perch production in Lake Victoria is increasing rapidly. Nile Perch (Lates niloticus) is a large, fatty fish with good eating quality. It is marketed fresh, frozen, smoked and fried. This paper discusses the technological characteristics of the Nile perch, the method of capture, handling, processing, distribution, marketing structure and constraints, and recommends appropriate measure to tackle the problems identified.

1. INTRODUCTION

The Nile perch (Lates niloticus) was not originally found in Lake Victoria. It is believed that it was introduced into Lake Victoria in the early 1960s. Since then it grew and multiplied and spread in the Lake. It was first caught in Uganda, and then in Kenya and lastly in Tanzania.

In Mwanza region, the Nile perch first appeared in 1980 in MV Mdiria[1/] catches. It spread quickly in Mara Region, Mwanza Region and on the Ukerewe Islands. The species composition in catches is shown in Tables 1 and 2 in Appendix A.

The appearance of the Nile perch is associated with the decline of the most popular fish in Lake Victoria, the Tilapia. Many fishermen and other people say that the Nile perch is eating the Tilapia and eventually the latter will become extinct.

Observations on gut contents show that the Nile perch is feeding mainly on the Haplochromis. It is also noted that the decline of Tilapia catches started before the coming of the Nile perch. However, there is a sharp decline of Tilapia catches since 1979.

The percentage fish catch composition for 1979, 1980 and 1984 shows that Tilapia accounted for 10.5%, 2.6% and only 0.2% respectively. The same data show that in 1979 catches of Lates niloticus was nil but in 1980 it accounted for 0.7% and in 1984 3.7%. Nyanza Fishing and Processing Company catches (Table 2) show that L. niloticus accounted for 57% in 1984 while Tilapia remained at 0.2% for both 1983 and 1984.

2. METHOD OF CAPTURE

L. niloticus is caught in all the fishing gears used in the Lake. These gears include trawl nets, longlines, beach seines, purse seines and gillnets. Conventional gillnets are not strong enough to catch large Nile perch. Such large fish make a hole in the gillnet and escape. Fishermen are therefore making special gillnets from nylon ropes to catch this fish.

3. TECHNOLOGICAL CHARACTERISTICS OF Lates niloticus

The Nile perch is a large freshwater, fatty fish with high fecundity. The largest fish caught by MV Mdiria at Nyegezi Freshwater Fisheries Institute was 86.5 kg in 1982. It is common to hear that a Nile perch weighing 100 or 150 kg was caught. The majority of the people prefer smoked or fried Nile perch to fresh. Due to its high fat content, boiling renders the fish unpalatable.

[1/] MV Mdiria is a steel, stern trawler which belongs to the Freshwater Fisheries Training Institute, Nyegezi, Mwanza. It started fishing in the Lake in 1971

4. HANDLING

Onboard the fishing vessel the Nile perch is separated from the rest of the fish and placed on deck in a corner. Sorting may be done into three size groups, that is, large, medium and small. The medium and small are not placed in containers at present. Normally, the fish is not descaled, gutted or iced onboard.

At the landing station or beach the fish is put on the ground, on the grass or in some places, it is put on mats made from reeds. There is no descaling, gutting or icing until the fish is sold. Marketing and distribution of the fish at the landing site is as shown in Appendix B. The price at the landing site is very low compared to the price at distant markets. The further away from the landing site the higher is the price.

In urban areas the fish is sold for cash. In rural areas sale by cash operates as well as bartering. The fish is exchanged for cassava or maize flour, fruits, etc.

5. PROCESSING

The present processing methods for Nile perch are: smoking, frying and freezing.

5.1 Smoking

Smoking of Nile perch is done in the usual way. The fish is descaled, gutted, washed, cut into small pieces if it is a large fish, spread out, drip-dried and then smoked. There is no brining. The smoking kiln used is the Altona type. A range of smoking materials are used. These include firewood, wood shavings, charcoal and grass prepared in tight, small bundles. The process takes about two days. The product is cooked, light-brown to dark-brown in colour with a reduced fat content than the raw material.

5.2 Frying

The preparation of the fish for frying is the same as for smoking, without brining. The pieces are much smaller than those for smoking. The fish is fried in its own oil made from the visceral fat. Pieces are placed in boiling oil and allowed to fry on one side until the colour is nicely brown and then turned on the other side. The number of pieces in the frying pan depends on the size of the pan. The amount of oil increases in the pan so that after a part of it is removed to avoid overflow which could result in flames.

5.3 Cooking of the smoked or fried products

The processed products can be eaten directly. Usually the product is prepared to be eaten in conjunction with cereal. A quantity of fish adequate for the number of consumers will be mixed with spices - onions, salt, curry powder etc. - and water and then cooked. No oil or fat is necessary. People along the coast add coconut to enhance the taste.

5.4 Freezing

The fish for freezing is normally gutted and then frozen whole. The frozen fish are packed in gunny bags and stored in the cold room until shipment.

6. DISTRIBUTION AND MARKETING

The distribution and marketing of Nile perch at the landing site has been described under handling and is diagramatized in Appendix B. Let us see a little more about the distribution and marketing of the processed products.

6.1 The fried products are transported over the shortest distance. In most cases the marketing is done within the town or near the processing site. Transportation is by bicycle, bus and on foot.

6.2 The smoked products are sent over a longer distance. The price increases with increasing distance, as shown in Appendix C, and also depends on how easily accessible the market is. The transportation of the product is by bus, lorry or train.

6.3 The popular markets for frozen Nile perch include Dar es-Salaam, Arusha, Moshi, Mbeya and Morogoro. These are large towns with big tourist hotels. The transportation of the product is by air. National Cold Chain Operations (NCCO) is the main distributor.

7. CONSTRAINTS AND RECOMMENDATIONS

7.1 People who prefer Tilapia to Nile perch complain to top Party and Government leaders that the Nile perch must be removed from Lake Victoria so as to allow the Tilapia to flourish again.

This problem should be scientifically approached by studying the biology of the fish so as to understand the behaviour of Nile perch and come up with recommendations for proper management of the fish resources in Lake Victoria.

7.2 Nutritional aspects of the Nile perch. The Nile perch is a good source of protein and fat and fat soluble vitamins.

Protein demand in Tanzania is very high. Red meats (cow, goat and pork) and poultry are very expensive, only a few people can afford to buy them regularly. Plant protein substitutes are also expensive and scarce. Hence a carefully planned transportation of the Nile perch will increase the protein supply and reduce protein demand.

At the moment there is an acute shortage of edible oil in the country. The oil consumed *per caput* is very low. This is associated with Vitamin A deficiency disorders. It is realized that during the time when fish oil was sold in the shops (cod liver oil, halibut oil, etc.) this problem was not so acute. Hence, the need to look at the prospects for utilizing Nile perch oil is sound and proper. Greater utilization will increase oil consumption *per caput* and reduce Vitamin A deficiency disorders.

7.3 Processing Methods. Current methods, particularly smoking, require improvements. Novice smokers end up burning the fish due to the oil dropping in kiln and causing fires. Some modification should be made on the kiln to collect the oil for use and avoid the problem.

Other processing methods should be introduced; for example, canning. Trials on canning showed that canning of Nile perch in tomato sauce is possible. A simple, cheap canning media like tomato sauce or brine is enough. Oil or mustard sauce is unnecessary.

7.4 Preparation of Nile perch. Those consumers who fry or use an oven in preparing the fish for eating do enjoy Nile perch. Direct boiling renders the fish unpalatable. Hence there is a need to educate the people on how Nile perch should be prepared for eating.

APPENDIX A

Table 1

Percentage Fish Production Composition in Lake Victoria, 1975-84. The fish was caught by MV. Mdiria using codends of 20 mm and 90 mm

DATE	TILAPIA	BAGRUS DOCMAC	CLARIAS MOSAMBICUS	PROTOPTERUS	LATES NILOTICUS	HAPLO CHROMIS	OTHERS	REMARKS
1975	21.1	5.2	5.6	17.8	0	49.6	0.7	Mainly 90 mm
1976	8.5	15.6	2.4	3.6	0	69.6	0.3	Mainly 90 mm
1977	12.4	0.4	4.5	32.0	0	50.4	0.3	Mainly 90 mm
1978	11.1	4.4	19.5	21.4	0	43.0	0.6	Mainly 90 mm
1979	10.5	8.5	3.8	3.7	0	62.2	1.3	Mainly 90 mm
1980	2.6	0.7	0.9	5.8	0.7	89.3	0	Mainly 20 mm
1981	0.7	0.9	1.2	6.2	0	91.0	0	Mainly 20 mm
1982	0.3	1.4	1.0	6.9	1.0	90.5	0	Mainly 20 mm
1983	0.6	1.3	1.0	10.4	5.5	81.2	0	Mainly 20 mm
1984 Sept.	0.2	0.3	0.3	2.8	3.7	92.7	0	Mainly 20 mm

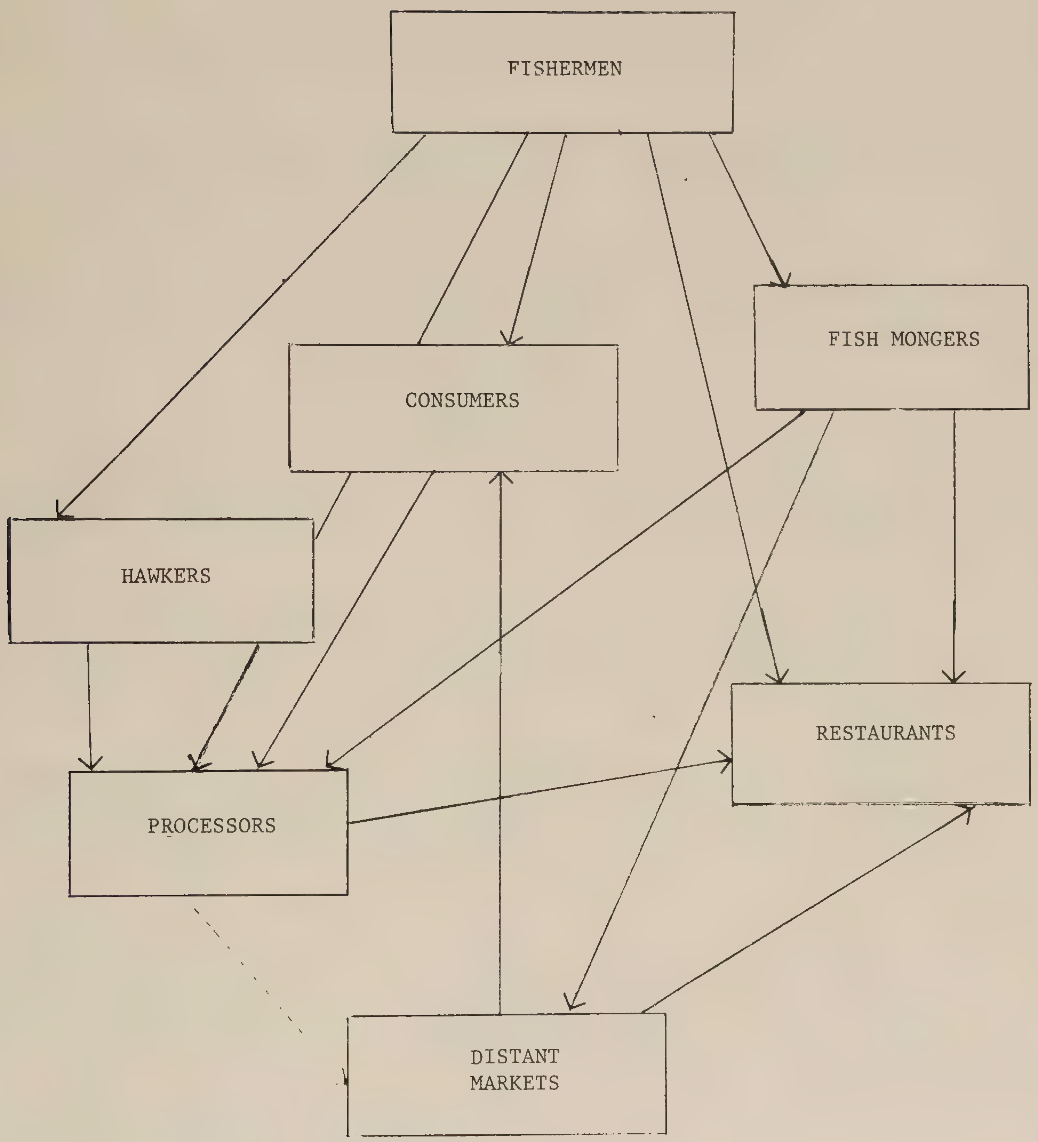
Table 2

Percentage Fish Production Composition in Lake Victoria, for 1983 and 1984. The fish was caught by Four Stern Trawlers using a 20 mm codend, NFPC Mwanza

DATE	TILAPIA	BAGRUS	CLARIAS	PROTO	LATES	HAPLOCH.	OTHERS	REMARKS
1983	0.2	0.5	0.4	2.0	1.8	95.1	0	20 mm
1984	0.2	0.5	0.7	3.5	5.7	89.4	0	20 mm

APPENDIX B

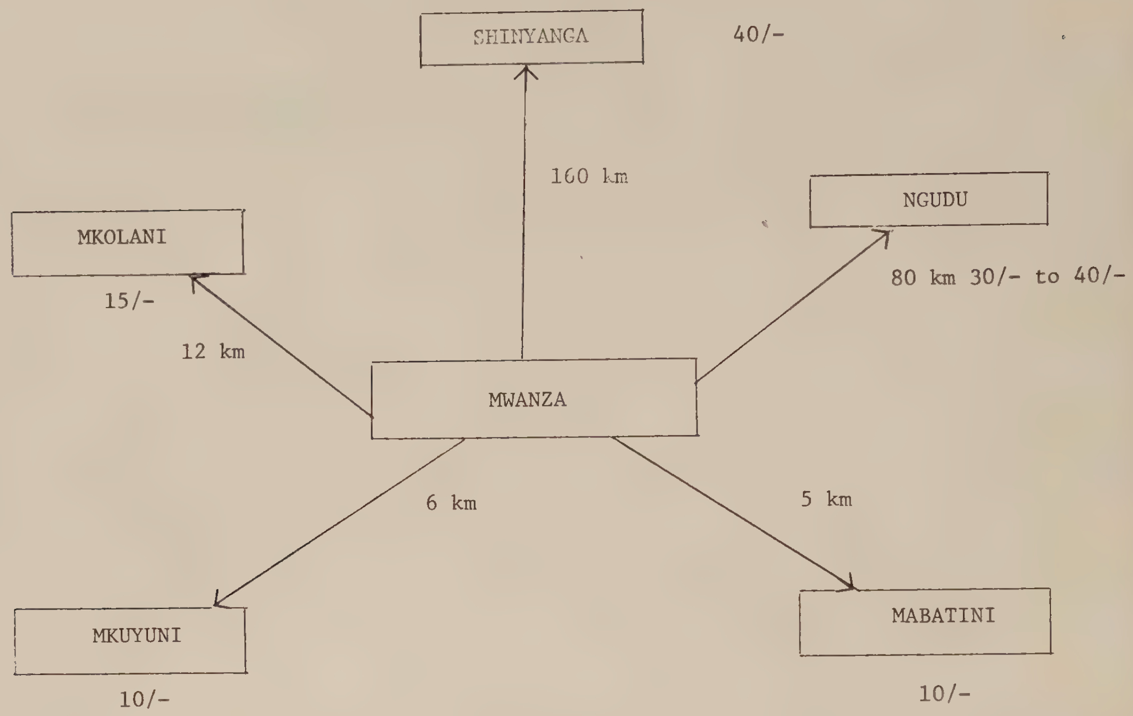
Nile Perch Distribution at the Landing Site


FISHERMEN
FISH MONGERS
CONSUMERS
HAWKERS
RESTAURANTS
PROCESSORS
DISTANT
MARKETS

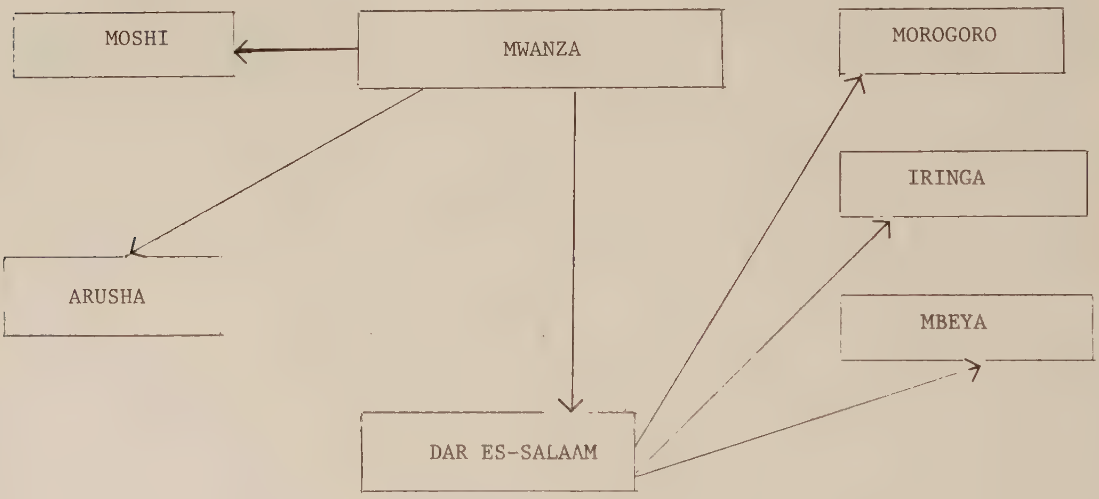
APPENDIX C

Nile Perch Distribution and Marketing in Tanzania

(a) Fried/Smoked Products


SHINYANGA
40/-
160 km
NGUDU
80 km 30/- to 40/-
MKOLANI
15/-
12 km
MWANZA
6 km
5 km
MKUYUNI
10/-
MABATINI
10/-

(b) Smoked/Frozen Product


MOSHI
MWANZA
MOROGORO
IRINGA
ARUSHA
MBEYA
DAR ES-SALAAM

L'ANCHOIS (*Engraulis encrasicholus*, LINNE 1758) DANS LA ZONE D'AL HOCEIMA: PECHE, INDUSTRIE DE TRANSFORMATION ET COMMERCIALISATION DES SEMI-CONSERVES

par

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RESUME

Le port de pêche d'Al Hoceima est le plus important port méditerranéen marocain. La pêche de l'anchois y est très importante aussi bien par le nombre d'unités de capture que par la main-d'oeuvre utilisée, par le tonnage debarqué et par le nombre d'usines de transformation.

D'après les dernières estimations (FAO, 1976), les potentialités de pêche de l'anchois dans la zone d'Al Hoceima sont de l'ordre de 8 000 tonnes par an. Actuellement, elles n'atteignent que 5 000 tonnes, pêchées par 36 senneurs. Ceux-ci, n'ayant aucun moyen de conservation à bord, font des sorties dépassant rarement la journée. On distingue deux périodes de capture:

- la première, s'étale de mars à septembre et correspond à la saison de bonne pêche au cours de laquelle le poisson s'approche des côtes pour se reproduire;
- la seconde, d'octobre à février, représente la saison des mauvaises conditions climatiques et pendant laquelle les zones de pêche se trouvent éloignées vers l'Est.

Au cours de cette période, les pêcheurs fréquentent l'Ouest, mieux protégé mais moins riche en anchois, la pêche est orientée alors vers la sardine représentant la deuxième activité du port d'Al Hoceima après l'anchois. Les apports des deux espèces montrent un phénomène de balancement entre elles. Au printemps et en été, 90 % de la pêche est relative à l'anchois alors qu'en hiver et en automne, la sardine représente 60 % des captures.

Le principal débouché de l'anchois est l'industrie de la salaison. Cinq unités ont été identifiées, dont la capacité totale approche 4 000 tonnes par an, employant 1 716 personnes dont 89 % de femmes ayant un faible degré de qualification et effectuant surtout un travail manuel.

Cette main-d'oeuvre est composée de deux catégories:

- saisonnière, travaillant essentiellement durant la saison de bonne pêche. Elle exécute l'importante phase du travail depuis le mélange de l'anchois avec le sel demi-gros jusqu'au remplissage des bordelaises pour la maturation du poisson. Cette dernière opération nécessite 5 à 8 mois à des températures comprises entre 12°C et 20°C;
- permanente, effectuant surtout l'emboitage, puis l'emballage des anchois pour la commercialisation.

Il s'agit d'une ancienne technique artisanale de conservation, appelée anchoitage. Elle est pratiquée par les populations de nombreux pays méditerranéens pour obtenir un produit dont la consistance est tendre et dont l'arôme et le goût sont agréables.

Ce processus est le résultat d'une activité enzymatique dans le muscle du poisson. La capacité conservatrice du sel est liée à ses propriétés antiseptiques et bactériostatiques. Toutefois les germes halophiles continuent à se développer et jouent un rôle important pour la maturation.

La presque totalité des demi-conserves obtenues est exportée vers les pays européens et quelques pays du Moyen-Orient. La CEE absorbe plus de 80 % des exportations (70 % pour la France) à des prix relativement rémunérateurs. Les autres marchés importent environ 18 %. Bien que la demande soit importante et dépasse la production, la commercialisation se heurte en particulier aux problèmes suivants:

- depuis la campagne 1979-80, une diminution est constatée dans la part destinée à la CEE. Ceci est dû à l'intégration au sein de la communauté, des pays producteurs de ce type de produit (Grèce et bientôt Espagne et Portugal), à la baisse du pouvoir d'achat des pays d'Europe occidentale, et à la substitution de cette semi-conserve par d'autres produits. Le délai de consommation des semi-converves d'anchois ne pouvant dépasser un an, l'expédition doit alors se faire dans les plus brefs délais, ce qui n'est pas toujours le cas. La valeur des produits en est alors affectée;
- enfin la forme de présentation des semi-conserves est parfois inadaptée à la demande de certains marchés extérieurs.

1. LA PECHE D'ANCHOIS

1.1 Introdution

La côte d'Al Hoceima est caractérisée par une alternance de barrières rocheuses qui sont parfois sous forme de falaises ou de baies plus ou moins étendues.

Elle est exposée aux vents dominants nord-est, affectant la pêche d'une façon importante.

Les eaux présentent des variations importantes de température et de salinité. Les valeurs les plus élevées se situent au niveau des baies, ce qui est à l'origine de la présence d'une grande quantité d'anchois pendant certaines périodes de l'année.

Pendant la période de mars à novembre, l'anchois s'approche des côtes et il a tendance à se retrouver dans toute la zone qui s'étend du Cap Tres Forcas à l'est jusqu'au petit port de Jebha à l'ouest; les captures y sont importantes.

Au moment où le poisson devient rare (octobre-février), il semble qu'il s'éloigne vers l'est.

1.2 Moyens et opération de pêche

La flotte de pêche est composée de 36 unités dont 18 d'une puissance supérieure à 300 CV. La jauge brute moyenne est de 50,18 t, la puissance moyenne est de 270 CV. La senne tournante est la méthode pratiquée par ces unités pour pêcher l'anchois. Ses dimensions varient en fonction des bateaux. Il s'agit d'un engin adapté au Maroc sous le nom de "Cerco", formé principalement d'une grande nappe de mailles uniformes. Sur toute sa longueur, le cerco est bordé d'une alèze dite gachette. En haut la gachette est de liège alors qu'au bas elle est de plomb. La poche placée à une extrémité de la nappe est de forme carrée, et possède un maillage assez réduit.

L'engin est terminé à chacune de ses extrémités par une aile à gros fil et à grandes mailles, l'aile avant est voisine de la poche, l'aile arrière est à l'opposé. Chaque aile reçoit à son extrémité libre un cordage. Des anneaux sont disposés sur toute la ralingue plombée, dans ces anneaux passe librement un cordage de fermeture.

La pêche se pratique la nuit à l'aide d'une puissante source lumineuse. La marée débute vers 17 h et se poursuit jusqu'à 7 h-8 h du matin, mais si les premières calées ont assuré de fortes captures, le bateau revient au port, débarque le poisson, et refait une seconde marée entre 2 h et 8 h du matin.

Dès que le banc de poisson est détecté, le bateau effectue un ou deux tours pour connaître la nature du fond, la profondeur et rassembler le poisson. Puis le canot qui porte la source de lumière est largué. Le bateau encercle alors le banc de poissons avec le filet jusqu'à ce qu'il retrouve le canot. On vire immédiatement au treuil la coulisse qui passe dans les anneaux pour fermer le filet on le remonte à bord et on met l'anchois dans les cales.

1.3 La production

L'anchois représente l'espèce la plus importante débarquée au port d'Al Hoceima.

Le tableau ci-dessous résume la situation de 1981.

Mois	Capture totale (tonnes)	% d'anchois
Janvier	575,03	15,81
Février	744,08	52,50
Mars	1 865,50	82,89
Avril	1 249,51	81,72
Mai	982,61	70,68
Juin	1 342,54	87,64
Juillet	1 267,95	92,57
Août	1 991,52	87,78
Septembre	1 469,13	63,89
Octobre	1 279,75	40,64
Novembre	1 232,08	74,74
Décembre	743,56	73,28
Total	14 743,26	Moyenne 80 %

Depuis 1976 la proportion d'anchois capturée par les senneurs n'a cessé d'augmenter (figure 1).

La fluctuation saisonnière de cette pêche d'anchois est importante. Sur cinq ans (figure 2), on constate que la pêche est étalée sur toute l'année mais les captures sont très faibles d'octobre à fevrier, le maximum se situent en été. Il a été remarqué que ces variations sont à l'opposé de celles de sardines.

Diverses études et constatations confirment l'importance du stock d'anchois sur les côtes méditerranéennes marocaines mais ce stock reste mal exploité et non protégé contre la flotte étrangère. La mauvaise exploitation est liée à l'insuffisance de la flottille locale aussi bien en effectif et dimension qu'en technicité, à l'infrastructure du port d'Al Hoceima qui est relativement rudimentaire et au nombre limité d'usines de salaison capables d'absorber en été les grandes quantités d'anchois débarquées.

L'absence de protection du stock d'anchois réside dans le fait que la flotte nationale ne représente que 30 % dans l'effort déployé sur les côtes méditerranéennes marocaines.

Quoiqu'il en soit la production actuelle d'anchois trouve trois débouchés: marché local, marchés hors du centre de pêche (Souks et villes proches) et usines de salaison qui en absorbent l'essentiel.

Bien que le marché local n'absorbe qu'une quantité faible d'anchois (1 % environ), l'anchois reste la principale espèce consommée par les habitants de la ville d'Al Hoceima en raison de son prix modéré (1 DH/kg).

Les Souks et les villes proches absorbent une quantité importante d'anchois (environ 50 % des captures), dans ces régions, le poisson représente un produit de première nécessité.

Toutefois pendant la période d'activité des usines de salaison (mars à septembre) cette quantité baisse d'une façon importante au profit des usines.

2. TRANSFORMATION - ANCHOITAGE

2.1 Généralités sur l'anchoitage

La salaison de l'anchois est un ancien processus de conservation de l'anchois, utilisé dans les pays méditerranéens pour obtenir un produit dont la consistance est tendre, l'arôme et le goût agréables. C'est le résultat d'une activité enzymatique et microbienne qui se déroule à l'intérieur du poisson.

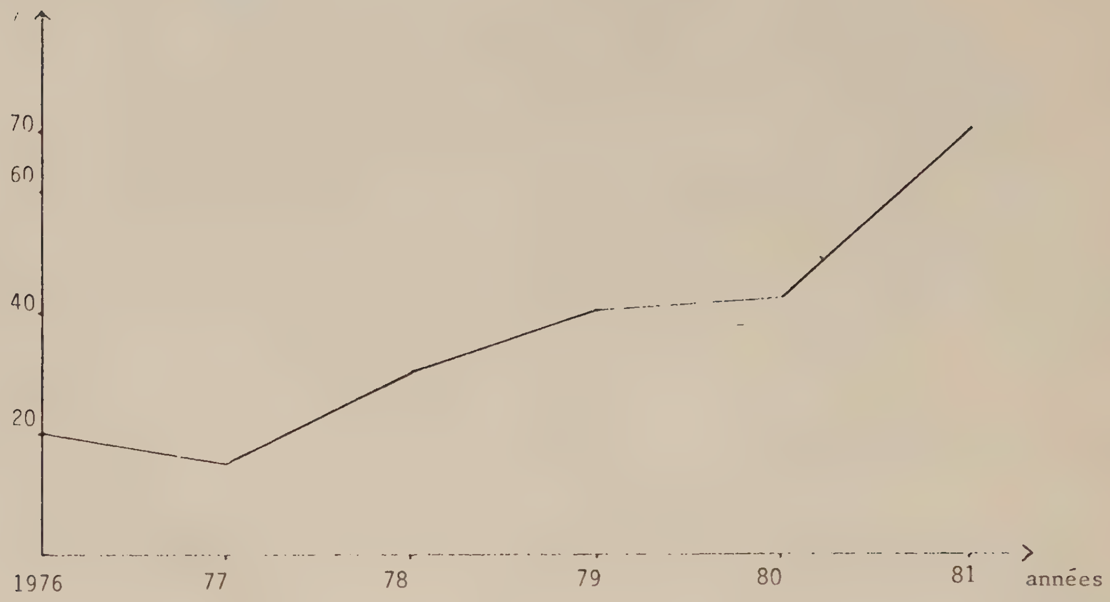

Figure 1 Evolution de la proportion d'anchois capturé par les senneurs (1976-81)

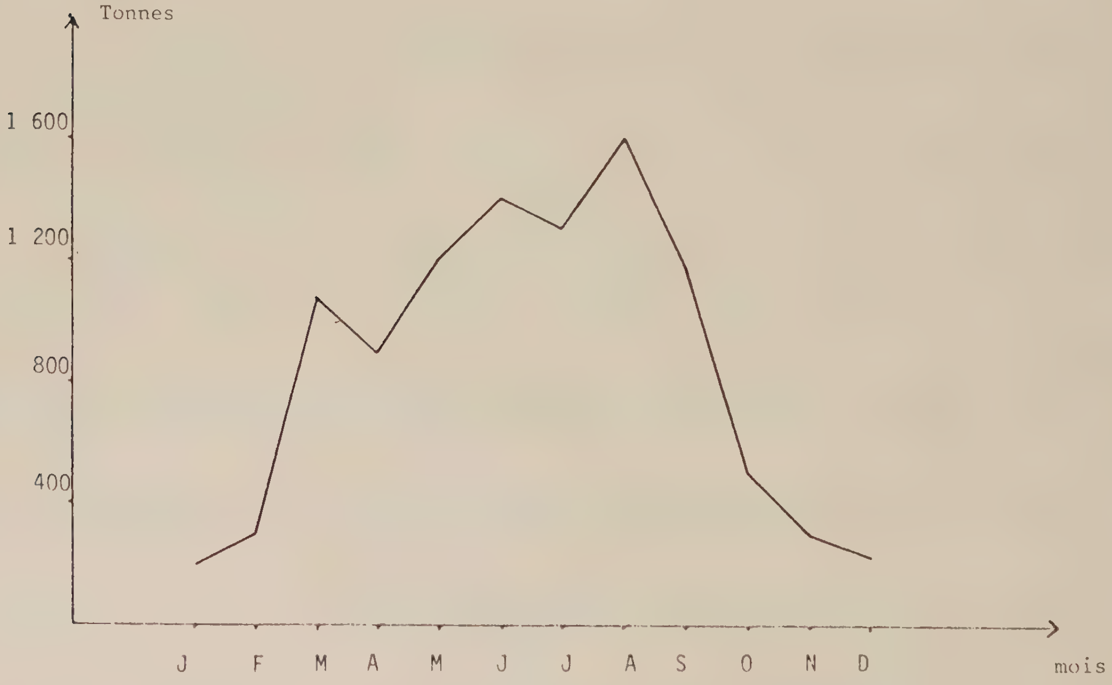

Figure 2 Variation saisonnière de la capture d'anchois sur cinq ans (1977-81)

L'anchoitage se fait encore à l'échelle artisanale, et comprend deux étapes:

- salage et maturation du poisson durant plusieurs mois;
- transformation du poisson anchoité en produit final.

La capacité conservatrice du sel provient de ses propriétés antiseptiques qui freinent le développement des germes. Ceux qui continuent à se développer sont généralement halophiles et jouent un rôle important sur la maturation. De plus, le sel provoque une déshydratation des poissons, ce qui limite encore le nombre de germes.

Diverses modifications interviennent au cours de la maturation du produit. Il s'agit tout d'abord d'une forte perte d'humidité. Ceci amène à une chair relativement ferme et sèche. Le rossissement de la chair qui s'amorce au niveau de la colonne vértébrale et de la cavité viscérale, le goût et l'arôme caractéristiques apparaissent avant que le poisson ne soit complètement mûr.

Par ailleurs, un changement biochimique important du tissu animal caractérise le processus de maturation. C'est ainsi que les protéines myofibrillaires et sarcoplasmiques sont dénaturées en grande majorité, parfois elles sont solubilisées. Les protéines dénaturées sont particulièrement sensibles aux enzymes protéolytiques.

Quant aux lipides, ils sont très sensibles à l'oxydation, les produits d'oxydation réagissent avec les produits de décomposition des protéines (aminoacides) pour produire des substances colorées et aromatiques. Ces lipides peuvent également s'hydrolyser par l'action des lipases contenues dans la chair pour produire les acides gras libres.

Toute une série de facteurs influencent la maturation en particulier la qualité du poisson qui doit être dans un état de fraîcheur parfaite, le sel qui doit être très pur, la température de stockage dont il faut éviter les variations, et la pression exercée sur les fûts dont le degré souhaitable est de l'ordre de 140 g/cm^2.

2.2 Les usines de salaisons d'Al Hoceima

A 1,5 km du port d'Al Hoceima se trouvent cinq unités de salaison. Ce sont:

(a) Société marocaine et franco-monégasque de conserves: c'est une société qui autrefois fabriquait des semi-conserves d'anchois et des conserves d'autres poissons tels que la sardine, le maquereau, etc. Mais actuellement en raison de la chute des débarquements d'une part et du départ des techniciens espagnols, cette société limite actuellement son activité à l'anchoitage;

(b) Société méditerranéenne de conserves: c'est une société maroco-française qui est uniquement spécialisée dans l'emboîtage des anchois salés;

(c) DEIRA: société Fco, des Santos Ladeira effectuant seulement les semi-conserves d'anchois;

(d) SALMAC: c'est une société qui fait uniquement l'emboîtage des anchois salés;

(f) SIMPA.

Pour l'ensemble de ces usines quelques opérations de traitement de l'anchois se font de manière mécanique, nous décrivons ci-dessous les principaux matériels employés:

- le lavage du poisson se fait à l'aide d'une machine qui exerce quatre opérations; la première à l'aide de l'eau à température ambiante, la deuxième avec de l'eau chaude à 60°C, la troisième et la quatrième avec de la saumure;
- le séchage du poisson s'effectue dans des centrifugeuses dont la capacité est d'environ 15 kg de poisson. Ces centrifugeuses tournent à des vitesses moyennes évitant ainsi la destruction des poisson;
- le jugate de la boîte et le sertissage se font par des machines automatiques uniquement pour les boîtes 1/15. Il existe des sertisseuses différentes pour chaque type de boîte, automatiques et à grand débit. Elles ne sont jamais utilisées à plein temps et leur entretien absorbe une bonne partie des charges;

- le salage final se fait dans des fûts de volume variable, mais les plus employés sont les bordelaises de 225 litres. De même, on utilise des fûts en matière plastique et des petites boîtes en fer blanc de 5 litres. Le pressage se fait par l'intermédiaire des blocs de pierre de 40-50 kg;

- machine à laver les boîtes après emboîtage, elles ont une capacité de 2 000-3 000 boîtes à l'heure (format 1/15).

2.3 Main-d'oeuvre

La main-d'oeuvre employée dans l'industrie des semi-conserves d'anchois est très importante, elle est essentiellement féminine (89 %), et le degré de qualification n'est pas très élevé. Les hommes qui représentent seulement 11 % de la totalité de la main-d'oeuvre effectuent surtout les travaux qui nécessitent une force importante (transport des caisses, remplissage des grands bacs, embarquement, etc.).

On considère deux catégories de travailleurs:

- une main-d'oeuvre saisonnière qui travaille principalement au moment où l'apport d'anchois est très important;

- une main-d'oeuvre permanente travaillant toute l'année et qui est spécialisée surtout dans l'emboîtage du poisson.

La distribution de cette main-d'oeuvre dans les cinq unités se répartit de la façon suivante:

Usines	Femmes	Hommes	Main-d'oeuvre saisonnière	Main-d'oeuvre permanente	Total
SIMPA	120	10	120	10	130
Société marocaine et franco-monégasque de conserves	250	45	255	40	295
DEIRA	350	40	130	260	390
SALMAC	356	45	110	291	401
Société méditerranéenne de conserves	450	50	120	380	500
Total	1 526	190	735	981	1 716
Pourcentage	88,93 %	11,07 %	42,83 %	57,17 %	

La durée du travail est de 8 heures par jour pouvant se prolonger jusqu'à 10 heures.

Les salaires sont fonction de l'âge, du sexe et du travail exécuté. Ils se distribuent de la façon suivante:

Age	Femme (en DH/J)	Hommes (en DH/J)
13-18 ans	7,50	-
20-30 ans	9,50	12,00
30-50 ans	10,50	13,00

2.4 Technologie de fabrication des semi-conserves

L'industrie de la fabrication des semi-conserves d'anchois salés s'effectue selon le schéma suivant:

PORT

USINE

Mélange avec du sel — 1ère opération
(24 heures)
Etêtage et eviscération — (2ème)
Lavage des anchois — (3ème)
Remplissage des bordelaises — (4ème)
(Maturation 5-8 mois)
Lavage des anchois — (5ème)
(eau → eau chaude → saumure 25°)
Séchage du poisson — (6ème)
Mise en filet — (7ème)
Emboîtage et vérification du poids — (8ème)
Couverture (huile de soja) — (9ème)
Sertissage — (10ème)
Emballage
Commercialisation

La qualité de la matière première constitue un élément important pour les conserveurs. Le poisson maigre est préférable au poisson gras car il mûrit plus rapidement.

Le sel influe aussi, d'une façon importante, sur la qualité du produit fini. Il faut un sel qui ne soit ni fin, ni trop gros, la plupart des conserveurs utilisent le sel N° 2 (2-3 mm de diamètre) qui n'entraîne pas un endommagement du poisson. Ce type de sel pénètre d'une façon satisfaisante à l'intérieur du poisson en préservant l'intégrité des tissus. Il doit être le plus pur possible et exempt de souillures; on préfère celui qui provient des marais salants.

Première opération: mélange de l'anchois avec du sel.

Elle consiste à mélanger le poisson avec du sel dans de grands bacs de capacité unitaire de 4 t. Avant de les remplir, on verse une quantité de 6-8 l de saumure à 25° Bé et au fur et à mesure qu'on introduit l'anchois on ajoute le sel. Après le remplissage du bac, on ajoute une quantité importante de sel à la surface jusqu'à obtenir une couche très épaisse. Les poissons doivent être laissés dans ces bacs pendant 24 heures au minimum c'est-à-dire jusqu'à la dissolution du sel qui est favorisée par la pression.

D'après les conserveurs, cette opération est la plus importante, car elle permet de se faire une idée de la qualité du poisson, ceci par l'exsudation de l'huile de poisson et du sang qui s'observent au dessus de la couche du sel.

Si la phase qui apparaît dans la couche superficielle du bac est de couleur rougeâtre, le poisson est de bonne qualité, sinon il est de mauvaise qualité et il doit être éliminé.

Pour certains conserveurs (Société marocaine et franco-monegasque de conserves) la première opération consiste à mélanger le poisson dans un premier temps avec du sel N° 4 puis dans un deuxième temps avec de la saumure.

Deuxième opération: étêtage et éviscération

C'est un travail manuel. Après le séjour du poisson dans le sel, le poisson est mis dans des caisses et transporté sur des tables pour l'éviscération et l'étêtage.

Pour 1 t d'anchois le poids des déchets à la fin de cette opération est d'environ 200-300 kg.

Huitième opération: vérification du poids

Après emboîtage, il y a vérification du poids, chaque type de boîte doit avoir un poids bien défini. La boîte 1/15 pèse 40 g, 1/2 pèse 500 g, 1/1 pèse 1 kg.

Neuvième opération: la couverture des anchois

On ajoute une quantité d'huile de soja soit manuellement soit à l'aide d'une juteuse couplée à la sertisseuse.

Dixième opération: sertissage

La dernière opération, consiste à sertir les boîtes contenant les anchois salés. Certains saleurs possèdent des sertisseuses qui sont capables d'effectuer en même temps le jutage mais seulement pour le format 1/15.

N.B. Certains conserveurs (SIMPA et Société marocaine et franco-monégasque) ne font pas toutes ces opérations; l'emboîtage s'effectue dans d'autres usines qui se trouvent à Casablanca et à Méhdia.

2.5 Conclusion

L'industrie de l'anchoîtage est une importante activité dans la ville d'Al Hoceima. Sa capacité globale de production est d'environ 4 000 t par an employant 1 716 personnes dont 89 % de femmes.

Les différentes opérations de traitement s'effectuent dans leur grande majorité d'une façon manuelle. Elles peuvent être classées en deux phases:

- la première phase est saisonnière, elle s'étend depuis l'arrivée de l'anchois à l'usine jusqu'au remplissage des bordelaises pour la maturation du poisson. Cette phase se déroule au moment où l'apport d'anchois est important, c'est-à-dire entre mai et septembre;

- la seconde phase est généralement temporaire, elle consiste en l'emboîtage puis l'emballage des anchois pour la commercialisation,

Différents problèmes entravent dans une large mesure le développement de cette activité industrielle.

Il s'agit principalement de l'irrégularité des approvisionnements des usines dont la capacité se trouve dépasée à certaines périodes. Il s'agit également de l'absence de système de congélation.

La qualité de la matière première pose également problème car le poisson est amené en vrac dans les cales où il reste plusieurs heures sans réfrigération. Cette qualité n'est pas bien contrôlée au cours de la salaison ce qui conduit parfois à un produit fini médiocre ou demandant d'allonger la durée de maturation. Un présalage à bord serait tout à fait indiqué.

Enfin il existe assez souvent une pénurie d'emballages, d'huile et de sel.

3. COMMERCIALISATION

Les semi-conserves d'anchois sont destinées essentiellement à l'exportation. Une grande partie est exportée par l'intermédiaire de l'Office de commercialisation et d'exploitation (OCE), l'autre partie échappe à ce réseau de commercialisation. Les conserveurs préfèrent alors livrer leur produit directement aux clients européens.

Le tableau ci-après donne une idée sur l'évolution du tonnage commercialisé par l'OCE.

Les autres marchés extérieurs sont par ordre décroissant:

- Grande Bretagne;
- Allemagne Fédérale;
- Belgique;
- Italie;
- Quelques pays du Moyen-Orient (Egypte, Liban, Arabie saoudite).

La durée de cette opération varie selon l'expérience des ouvriers. En général une femme peut étêter et éviscérer jusqu'à 30 kg d'anchois à l'heure.

- Troisième opération: lavage des anchois

Une fois l'opération précédente terminée, les anchois sont lavés soit dans des machines, avec une saumure à 25° Bé, soit manuellement dans la saumure.

Quatrième opération: remplissage des bordelaises ou des boîtes de 5 litres

Après lavage des bordelaises, on met un peu de sel N° 2 pour couvrir le fond, et on peut procéder de deux manières:

(a) mélange d'anchois avec du sel et mise dans les bordelaises.

On met alternativement une couche d'anchois et une couche de sel N° 2 jusqu'au remplissage des bordelaises. On place ensuite un morceau de bois au-dessus et un gros bloc de pierre dont le poids est d'environ 40-50 kg, ceci pour presser le poisson afin qu'il élimine le liquide qui apparaît au niveau de la couche superficielle de la bordelaise. La pression au-dessus du poisson est nécessaire car elle accélère le phénomène de maturation;

(b) remplissage des bordelaises en couches alternes, dans ce cas le poisson est bien rangé, ce qui évite qu'il ne soit abîmé. Quant le fût est rempli, on le couvre à l'aide d'un disque de bois sur lequel on ajoute un bloc de pierre comme précédemment.

Notons que le salage final se fait dans des fûts de volume variable. Certains conserveurs utilisent des boîtes de 5 litres qui sont exportées directement à l'étranger pour subir les autres opérations de traitement.

D'autres industriels utilisent les bordelaises de 225 litres en bois de chêne, ou des fûts en matière plastique. Ces derniers sont d'une utilisation et d'un entretien beaucoup plus commodes, mais, d'après les conserveurs, ils ne donnent pas un anchoitage d'aussi bonne qualité que celui effectué dans les fûts en bois. Les bordelaises en bois maintiennent la température d'une façon assez constante, alors que la température dans les fûts en plastique varie en fonction de la température extérieure, ce qui donne au poisson un goût et une odeur particuliers. En outre, plus la température est élevée, plus la durée de maturation est courte.

Les bordelaises sont ensuite laissées dans des locaux à températures variant entre 12°C et 20°C, pendant une période de plus de six mois c'est-à-dire, jusqu'à la maturation complète du poisson. La température ne doit pas dépasser 28°C. Cette maturation est nécessaire car c'est elle qui confère au produit ses qualités organoleptiques, goût, flaveur et odeur sans lesquelles le poisson n'est pas "anchoité".

Cinquième opération: lavage de l'anchois

Une fois le poisson anchoité, c'est-à-dire ayant acquis un goût et un arôme caractéristiques avec apparition d'un liquide rougeâtre sur la partie superficielle du bordelaise, on le retire et on le fait passer dans une machine qui exerce quatre opérations de rinçage:

eau → eau chaude à 60° → saumure 25° → saumure 25°

En effet, d'après les "saleurs", on lave le poisson à l'eau dans un premier temps afin d'éliminer toutes les impuretés, puis on le place dans une saumure 25° pour qu'il garde sa rigidité en vue de son traitement lors des opérations ultérieures.

Certains conserveurs utilisent après cette opération, un mélange d'eau et de vinaigre (20 l d'eau pour 1,5 l de vinaigre) qui donne au produit un goût et une odeur particuliers appréciés par les acheteurs européens. Cette opération nécessite du temps, de l'ordre d'une heure par tonne de poisson.

Sixième opération: séchage de l'anchois

Après lavage des anchois, on les met dans des caisses de 16 kg pour être séchés dans des centrifugeuses. Celles-ci ont une capacité de 16 kg de poisson, et tournent à une vitesse très moyenne évitant ainsi toute destruction du poisson.

Septième opération: emboîtage des anchois

Cette opération consiste à mettre les anchois en filet et les placer dans des boîtes de différents formats: 1/15, 1/2, 1/1.

Années	77-78	78-79	79-80	80-81	81-82
Total	1 850	2 470	3 530	3 676	4 330
Part de la CEE	1 787	2 414	3 201	3 184	3 020
Vers la France	1 616	2 252	2 937	2 743	2 625
France total	87,45 %	91,17 %	83,2 %	74,62 %	60,62 %
Autres pays	63	56	329	492	1 310

D'après ces statistiques, on note que le marché de la CEE où les prix sont relativement rémunerateurs, absorbe à lui seul plus de 80 % des ventes globales.

A l'intérieur de cette communauté, la France absorbe presque totalement à elle seule la production marocaine.

Les autres marchés importent environ 18 % de nos semi-conserves d'anchois. On constate aussi d'après le tableau précédent qu'il y a depuis la campagne 79-80 une nette diminution de la part qui est destinée à la CEE, ceci pourrait être dû aux facteurs suivants:

(a) intégration (probable) au sein de la CEE de pays producteurs de ce type de produit; Espagne, Portugal, Grèce etc. On tend donc vers une autosuffisance de ce marché;

(b) baisse du pouvoir d'achat qui est la conséquence de la crise économique que traversent les pays de l'Europe occidentale;

(c) substitution ce cette semi-conserve par divers produits alimentaires. En effet le consommateur européen se détourne peu à peu de ces semi-conserves d'anchois.

4. CONCLUSION GENERALE

Sur la partie méditerranéenne de la côte marocaine, le stock d'anchois occupe le premier rang au sein des différentes espèces de poissons. Ce stock reste encore sous-exploité en raison d'insuffisance d'infrastructures aussi bien en amont qu'en aval.

L'extension du port d'Al Hoceïma et l'augmentation de l'effectif des bateaux prévue prochainement auront un effet positif sur cette activité de pêche.

Cependant, les importantes quantités qui seront débarquées se heurteront à de sérieux problèmes d'écoulement si des mesures de redressement ne sont pas prises. Ces mesures concerneraient essentiellement le principal débouché, à savoir l'industrie des semi-conserves et leur commercialisation. Il faut prévoir en particulier:

(a) l'agrandissement du secteur de l'industrie des semi-conserves par l'implantation de nouvelles unités afin d'absorber une plus grande quantité d'anchois;

(b) l'installation de moyens de congélation afin de régulariser la gestion des usines;

(c) l'élargissement du réseau de commercialisation intérieure en acheminant le produit vers d'autres régions marocaines;

(d) la recherche d'autres marchés extérieurs afin de réduire notre dépendance vis-à-vis de la CEE.

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BECHE-DE-MER PROCESSING TRIALS ALONG THE EGYPTIAN RED SEA COAST

by

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ABSTRACT

Three species of sea-cucumber have been studied, teat fish, (Microthele nobilis), black fish (Actinopyga sp.), and surf red fish, (Actinopyga mauritiana). Samples were taken from fishing grounds with rocky and sandy bottom. The animals were collected by skin-divers at depths of 2-3 m.

Discussions with the fishermen revealed that the reefs bordering the islands have extensive resources especially in waters of 12-20 m.

Teat fish are large, whereas the black fish and surf red fish are small. The yield of the product after processing varied between 8-12% of the initial weight, the moisture content of the product on wet weight basis varied between 14-24%.

1. INTRODUCTION

Beche-de-mer (sea cucumber) is related to starfish and sea urchin and belongs to the class Holothuroidea in the Phylum echinodermata. It is a worm-like animal, free moving, bottom living and soft bodied. The body is cylindrical and elongated with a very thick body wall. The surface of the wall has protrusions known as tubercle.

Sea-cucumber with six lateral teat-like projections (papilae) Microthele nobilis fetches the highest prices in the market. The mouth at one end is surrounded by tentacles which in some species trap suspended food items, but in the most common species the tentacles are used to put sand into the mouth, and the animals obtain nourishment by digesting the various organic matter, on and between the particles. Papillae and pedicels occur at the dorsal side of the animal. The ventral surface has long narrow retractable tube feet. They are used as suckers. The posterior opening of the gut (anus) usually has five anal teeth; each of these has a hard (calcified) triangular structure embedded in the anal wall.

The most common type of holothurian in the Red Sea is a black one Holothuria atra which is found often in large numbers lying on the sand in shallow water; it has no commercial value.

Harvesting of beche-de-mer (H. scabra) in the Egyptian Red Sea area has never been carried out up to now. The fishermen who dive for lobster and shellfish have observed the animals on the reefs. They have no interest in collecting it as it is economically unattractive and there is no demand locally. In South East Asia the animal is in big demand among the Chinese population where it is thought to possess some aphrodisiac properties. It has become part of the life and traditions for festive occasions. Purchased in dry form, it is soaked in water, cleaned and cooked in many delicious ways. It is rich in protein. The dried product has the following nutritional composition:

Protein	43%
Fat	2%
Moisture	27%
Minerals	21%
Insoluble ash	7%

Exploratory fishing trips (17 May - 1 June 1983) have been carried out north of Hurghada to locate beche-de-mer. Harvesting involves diving for them in up to 2 m depths between reefs. The animals are easy to capture as they offer no resistance.

A sample of 23 kg were collected in two hours by two fishermen. Two species were collected: Microthele nobilis (Abouo-Ebzaz, local name) and Actinopyga mauritiana (Abo-Teriefa, local name). A sample of 25 kg of Actinopyga sp. (Abou-Sandok, local name) were also collected by the fishermen from sandy surfaces.

2. OBJECTIVES

The objectives of the trials were (a) to promote the utilization of beche-de-mer as a new product (b) to demonstrate to the Fishermen cooperative societies along the Red Sea how the animal can be processed and to encourage them to utilize their natural fishing resources on a commercial scale.

3. MATERIAL AND METHODS

3.1 Material and Processing Procedures

The samples collected were supplied to Hurghada processing area on 17 May, 24 May and 25 May 1983 in a live condition.

Surf red fish has a deep brown upper surface, the lower surface is light brown. The outer skin layer spoils the appearance of the final product which affects its marketability, so the processing technique of this animal is slightly complicated. A small opening is made near the mouth to effect evisceration. The animal is gently squeezed to eviscerate and expel the water. After eviscerating, the animal is washed in clean sea water. A saucer shaped pan (Attai Chatti of 120 cm circular rim and 40 cm depth at the centre) of cast iron is used for cooking the animals. The animals were introduced into the boiling sea water. The cooking time was 45 minutes. Frequent stirring during cooking was necessary. Cooking was achieved when the animals attained a blubber-like form; they are said to 'bounce like a ball' when dropped on the floor. After cooking the animals were buried overnight in clean, moist sand in order to soften the outer skin layer by the action of bacterial decomposition.

A stiff brush was then used to clean the outer skin layer. After that the animals were boiled again in clean sea water for half an hour.

Teat fish processing is simpler. The animals are introduced into boiling sea water; stirred continuously until the animal swells up; removed to cool. After cooling, a longitudinal slit was made on the mid dorsal side, not extending into the anus or the mouth. The animals are finally boiled in sea water for 30-45 minutes until the flesh is hard.

3.2 Drying

After boiling, slitting and reboiling in the case of teat fish and after boiling, cleaning and reboiling in the case of surf red fish and black fish, the animals were spread on racks and subjected to solar heat for drying. After five to six days the product had a hard texture. Weight and moisture contents were recorded twice daily.

4. RESULTS

4.1 Surf Red Fish

After 54.00 hours processing and cleaning, the animal lost 80.80% of its initial weight. The moisture content of the fish at the start was 80%; after 54.00 hours the moisture content was 68%. During the drying process the weight of the animal had decreased, and after 114.30 hours drying the animal lost 60% of its weight after processing, and 92% from its initial weight. Changes in weight and moisture content are shown in Table 1. The number of pieces of end-product per kilo is 24.

4.2 Teat Fish

After processing the animal lost 64% of its initial weight. The moisture content of the fish at the start and after 1.30 hours was 84% and 74%, respectively. After 140 hours drying the moisture content was 24% and the animal lost 68% of its weight after processing and 88% of its initial weight. Changes in weight and moisture content are shown in Table 2. The number of pieces of dried product per kilo is 8.

4.3 Black Fish

During the stages of processing and cleaning (56.00 hours) the animal lost 81% from its initial weight, and the moisture content had decreased from 84% at the start to 70% after 56.00 hours. After 100.30 hours drying, the moisture content was 14% and the animal lost 93% of its initial weight in the drying process and 64% of its weight after processing. Changes in weight and moisture content are shown in Table 3.

The number of pieces of the dried product per kilo is 41.

5. DISCUSSION

The drying rate depends upon the surface area exposed, the temperature, relative humidity and and the speed of the air over the holothurian.

The higher drying rate of black fish during the first two days of drying compared with teat fish and surf red fish was attributed to the high wind speed and lower atmospheric relative humidity. The saturation point of the atmospheric relative humidity was 44% and the surface wind speed was 20 ff.

This resulted in a moisture drop from the initial level of 84% in black fish to 27%, and in the other two types of fish from the initial level of 84% to 50% (Table 1, 2 and 3).

There was an additional drop in moisture with further drying to reach 14% after 100 1/2 hours for black fish and 17% after 114 1/2 hours for surf red fish, and 24% after 140 hours for teat fish.

The drying time of teat fish was prolonged and this is due to the thicker body wall of the animal.

The product was found to be acceptable organoleptically in term of colour, aroma, and texture. However, chemical, and microbiological studies on the product need to be conducted especially for surf red fish and black fish. With reference to handling and preservation of the animal on board, there is no need for ice and or an insulated container for preservation and storage of the fish after collection. A plastic container with sea water was used to keep the fish for two days without ice in order to protect from the sun; the animal could still remain alive for two days.

Preparation of some species of sea-cucumber is difficult, because in these species there is a need to remove the pigmented outer skin layer which spoils the appearance of the product; this can be done by the action of bacterial decomposition through burying the animal after cooking for sometime in clean sand; the outer layer is softened and has a fetid odour. Removal of the fetid remnants and the outer skin layer is a tedious task and the fishermen have no ability to process these species. With further processing and drying the smell of decomposition disappeared and the animals become hard.

6. RECOMMENDATIONS

6.1 Feasibility study on the prospects of a beche-de-mer fishery in the Egyptian Red Sea coast should be undertaken to ensure that the fisherman will benefit from this fishery; the main species for exploitation are the holothurians belonging to the genera Microthele/Actinopyga.

6.2 Fishermen operating for beche-de-mer should be trained to dive in deeper water using aqua lungs.

6.3 Care should be taken during collection and initial preparation of the animal to avoid the sticky threads coming into contact with the skin.

Table 1

(a) Percentage loss of weight and moisture content of
surf red fish during processing and drying

Hours of processing/drying	% of initial weight	% moisture content
00.00	100	80
54.00	19.20	68
114.30	7.72	17

Table 1 (cont'd)

(b) Percentage loss of weight and moisture content of surf red fish during drying

Hours of drying	% of initial weight	% moisture content
00.00	100	68
5.00	86	64
18.30	69	58
28.30	55	52
42.30	51	50
52.30	46	39
66.00	45	-
76.30	42	27
90.00	42	19
100.00	41	18
114.30	40	17

Table 2

(a) Percentage loss of weight and moisture content of teat fish during processing/drying

Hours of processing/drying	% of initial weight	% moisture content
00.00	100	84
1.30	36.26	74
140.00	12.50	24

(b) Percentage loss of weight and moisture content of surf red fish during drying

Hours of processing/drying	% of initial weight	% moisture content
00.00	100	74
12.00	82	69
22.00	62	-
34.00	53	51
44.00	45	-
58.00	44	41
68.00	37	-
82.00	36	33
92.00	35	-
106.50	33	30
116.50	33	29
104.00	32	24

Table 3

(a) Percentage loss of weight and moisture content of black fish during processing/drying

Hours of processing/drying	% of initial weight	% moisture content
000.00	100	84
2.17	24	79
56.00	19	70
100.30	6.64	14

(b) Percentage loss of weight and moisture content of black fish during drying

Hours of drying	% of initial weight	% moisture content
000.00	100	70
4.30	73	53
19.00	53	48
29.00	45	31
42.00	42	27
52.00	40	25
66.30	39	18
76.30	38	16
90.30	37	20
100.30	36	14

PRODUCT TECHNOLOGY OF SKIPJACK TUNA CAUGHT IN NIGERIA'S EEZ

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ABSTRACT

Product development work for utilization of skipjack tuna for human and animal feeding was investigated by employing existing technologies. This involved the production of smoked tuna, minced fish from tuna and the production of fish meal from tuna wastes. These products were examined for their composition, storage stability and acceptability.

The two smoking trials gave a yield of between 30% and 33% with an average of 31.59% of the smoked product. Soaking in water in the second trial for two hours before smoking reduced the salt content with a proportional increase in protein content of the smoked-dried products. Mouldiness appeared to constitute a major storage problem in smoked tuna. The fungi responsible for this could not be identified for lack of facilities.

Mince production using a BAADER 694 meat/bone separator gave a yield of 84% of meat which amounted to 63.54% on the whole fish basis. The mince is high in protein (23.87%) and could be used in food preparation and in fast food outlets for the manufacture of fish pies, fishfingers, fishburgers and cakes. However, its dark colour may militate against its acceptability.

Trials designed to reduce the colour of the mince included washing with clean fresh water, addition of different amounts of raw and hydrogenated vegetable oil; and the use of diluted solution of hydrogen peroxide in phosphate buffer.

The first of the three methods did not produce the desired effect, as the washed mince contained too much water. Organoleptic assessment of the mince treated with 4% vegetable oil, either in the cooked or uncooked form, produce a relatively better and more acceptable mince.

On isolation and neutralization of the mince treated with hydrogen peroxide, the most desirable and most stable mince was obtained at pH8. At pH4 and pH6, the mince developed a light greenish colour (possible formation of struvite) when stored for 24 h at low temperature.

Fishmeal produced from tuna wastes contained a fairly high amount of protein, 7.75%, Ca, and 4.6%, P. The significance of fishmeal production in Nigeria was examined.

1. INTRODUCTION

Greater utilization of pelagic resources can be achieved by improving or developing conventional methods which involved avoidable spoilage, deterioration and waste. The literature on the developed technologies for processing pelagic resources into direct human foods is extensive. Those related to West African situation, as enumerated by Talabi (1982), can be classified under the following:

(a) storage and marketing at low temperature,

(b) use of additives

(c) drying

(d) sterilization.

Storage and marketing of pelagic fish species as frozen products are very desirable if the facilities are available. In West Africa, this is not the case. Even where there is some form of developed network, the problem of the high energy required to maintain good quality throughout the distribution line is tremendous.

Mechanical separation of meat from bone for further processing is of considerable potential. Separated meat can be frozen and sold to food processing plants to be used as meat extenders in sausage manufacture. Efforts in this direction are hampered by the lack of adequate plants and the reluctance to venture into the processing of fish and fishery products.

Dried and smoke-dried fishery products are very important in the diet of West Africans. These are either produced by drying by means of solar energy or by heat energy produced by burning charcoal or wood. The main problems with sun-dried fish are insect damage, sand contamination and a generally low quality caused by the slow rate of enzyme and bacterial inactivation. On the other hand, smoking by means of heat energy from wood or other fuel is a high energy process. Problems of bulk processing of large quantities of fish also arise. Smoking kilns which can handle large quantities of pelagic fish economically do not seem to exist.

In a bid to improving the utilization of Nigeria's pelagic resources, a survey was recently initiated to assess the availability and abundance of skipjack tuna within Nigeria's Exclusive Economic Zone (EEZ). This is to enable the formulation of a rational policy on its exploitation and utilization.

The existing technologies available at NIOMR were therefore used in establishing the potential of tuna as a food. The intrinsic technological and biochemical properties were established (Balogun and Talabi, 1984), and these were used to identify the possible forms of utilization of tuna either directly for man or indirectly for livestock.

Thus, the present study reports on the possibilities for the use of:

(a) an NIOMR kiln for the commercial production of smoked tuna;

(b) a mechanical meat/bone separator (BAADER 694) for mince production of tuna;

(c) a fishmeal plant for the utilization of wastes.

The work also examined the use of existing technologies in the lightening of dark coloured mince produced from tuna in order to enhance its consumer acceptability.

2. MATERIALS AND METHODS

Collection of Samples

Skipjack tuna (Katsuwonus pelamis) used for the investigation was caught by a chartered Japanese boat (FUKUICHI MARU No. 78). This vessel was equipped with "pole and line" and storing facilities for skipjack tuna and tuna-like species. After landing of the catches at Ijora Jetty, a total consignment of 500 kg were collected and used for the product development work at the Fish Technology Division of the Nigerian Institute for Oceanography and Marine Research (NIOMR).

2.1 Smoking of Tuna

Two main smoking trials were carried out using the NIOMR mechanical smoking kiln. A description and mechanism of operation of the kiln have been given by Talabi and Igbinosun (1981).

In the first trial, about 100 kg of frozen tuna were used. This was washed with fresh, clean water, eviscerated and cut into steaks of between 4.50 cm and 5.50 cm thick. The steaks were dipped into a food grade smoke flavour (supplied by White Stevenson, UK), injected with 3% salt, 3% vegetable oil and 6% vinegar in water. After draining, they were reweighed and then smoke-dried for about eight hours at $80^{\circ}C$.

After ensuring proper dryness, the smoked samples were allowed to cool overnight. Samples were withdrawn from this batch and triplicate analyses for proximate composition and salt content were carried out. Samples were randomly distributed among the staff of NIOMR for consumer acceptability or otherwise.

Based on the response from this, a second trial involving the smoking of another batch of 120 kg was carried out. The fish were cut into steaks and soaked in water for about two hours. They were dipped in smoke flavour and all the treatments in the first trial were included. After draining, they were then smoked as described in the first trial. After cooling, samples were analysed for proximate composition, salt content and their consumer acceptability assessed. Yields from these two operations were recorded as differences between the weight of drained fish before smoking and weight of smoke-dried fish.

2.2 Mince Production from Tuna

About 50 kg tuna fish were washed thoroughly with clean fresh water, beheaded, gutted and cut into pieces. The cut pieces were again washed thoroughly with water and allowed to drain. They were then weighed and passed through a BAADER 694 meat/bone separator. The mechanism of operation of this machine has been described by Akande and Talabi (1981). Samples were withdrawn for proximate analysis, salt content and for sensory evaluation (using untrained panelists).

The mince produced was weighed and packed in sealable polythene bags (5 kg packs) and frozen to -30°C in a horizontal plate freezer.

Development work to improve the colour of tuna mince: Based on the sensory evaluation, development work to lighten the intense dark colour of tuna mince was carried out.

(a) Washing of the mince with fresh water. A known quantity of the mince was washed in an equivalent amount of water (wt/vol) and left at a temperature of 2°C for about two hours. The mixture was then strained through muslin and the recovered mince examined for moisture, protein and colour.

(b) Addition of raw and hydrogenated vegetable oil to the mince. 4%, 6% and 8% (wt/wt) of raw and hydrogenated (Margarine) vegetable oil were added to the mince. The mixtures were blended for about five minutes in a Kenwood blender. In each case, the mince was divided into two portions. One half was left uncooked while the other half was steam-cooked for about 30 minutes in casserole dishes. Both the steamed and uncooked mince were organoleptically assessed for appearance, texture, colour, juiciness and flavour. These attributes were graded on a scale ranging from 1 to 8, 1 (one) denoting extreme dislike, 8 (eight) denoting extreme likeness; a score of 4.5 was regarded as the threshold point denoting neither like nor dislike.

(c) The use of dilute solution of hydrogen peroxide to lighten the colour of tuna mince. The lightening process was carried out according to the procedure described by Young et al. (1980) in a range of citric acid - disodium orthophosphate buffer solutions (pH2 to pH8) prepared according to the procedure of Dawson et al. (1962).

Residual hydrogen peroxide was reduced by the addition of sodium sulphite. After adjusting the pH to 7.0 ± 0.2 with either sodium hydroxide or hydrochloric acid, the mince was filtered and then washed thoroughly with water. After washing, the mixture was sieved. After proper draining, the products were then packed in sealable polythene bags and observations were made on the colour change over the range of pH buffer solutions used.

2.3 Fish Meal Production from Tuna Wastes

Beheading and evisceration of Skipjack tuna generated about 30% wastes (Balogun and Talabi, 1984). These wastes were processed into fish meal using the fish meal plant of the Fish Technology Division of N.I.O.M.R. (model T100 supplied by Chemical Research Organisation, Esbjerg, Denmark).

The product was then hammer-milled to produce finely powdered fish meal. Samples were taken for proximate and mineral composition.

3. RESULTS AND DISCUSSION

3.1 Smoking Trials

The yield data of smoked tuna are presented in Table 1. It is evident that the yield of smoked tuna was 30% in the first batch and 33.19% in the second batch with an average of 31.59%; and this yield compares favourably with the yield obtained for smoked P. typus (croaker) using the NIOMR mechanical kiln.

The proximate compositions of the two batches of smoked tuna are presented in Table 2. Pre-smoking treatments affected the composition of the two batches. The high salt content appeared to have affected the acceptability of this batch by consumers as revealed by the sensory assessment of the product. Most of the consumers complained of the high salt content. Based on this preliminary information, soaking in water for two hours before smoking (second trial) reduced the salt content to 3.77 ± 0.12% with a proportional increase in the protein content (75.45 ± 1.96%) in the second batch.

Sensory assessment showed that this batch was fairly acceptable, although the complaints about saltiness were not completely eradicated. However, most consumers felt that this does not constitute a problem as the residual salt could be reduced by soaking the smoked fish in water for about 30 - 45 minutes before using it for cooking.

A major problem encountered during the storage of smoked tuna was the growth of moulds. Liston (1980), reported that hard-smoked and dried fish products are normally spoiled by moulds. In a recent study of smoked and dried fish from tropical regions, Phillips and Wallbridge (1977) reported the isolation of Aspergillus (five species), Penicillium (five species), Scremonium and Rhizopus. Most of these fungi are capable of growth if the relative humidity rises above 70%. Since smoked tuna is a new product, most of the fungi species likely to infect it were not known and efforts to identify some of the species were not very successful because of lack of facilities. If smoked tuna is to be introduced into the Nigerian market, efforts should be made to initiate studies in this direction in order to establish proper control. This is also important because the production of mycotoxins by moulds has recently become a matter of increased concern because of their significance in human health.

3.2 Mince Production from Tuna

Yield data, proximate composition and salt content of mince produced from tuna are presented in Tables 3a and 3b. Data presented in preceeding section showed that, while smoking may be used to increase the shelf life of tuna in Nigeria, the yield from this operation needs to be improved. It is evident from Table 3a that mince produced using the "BAADER 694" meat/bone separator was obtained in a yield of about 84%. Expressed on a whole fish basis, the yield was 63.54%. This was far better than the yield of 31.5 % obtained during smoking. It is hoped that the mince will find extensive use in fast food for the production of outlets sausages, fish pies cakes and fish fingers. The mince also has a high protein content (23.87 ± 1.02) and a low salt content (1.48 ± 0.12) which will further enhance its utilization by Nigerians in the cooking of vegetable stews. It is important to point out that the tuna mince produced in this way is intense dark red which may militate against its consumer acceptability.

It is in realisation of this problem that the product developmental work to lighten the colour of the mince was carried out.

Efforts to wash the mince with water did not produce the desired effect. Connell and Hardy (1982) have described the coloured constituents of coloured mince as very complex, consisting of flesh pigments like haemoglobin from blood and other haem pigments. They observed that simple removal of the pigment by washing with water is not feasible except when undenatured blood is the major component; a substantial whitening can be achieved at the risk of increased cost and increased water content. Our experience with tuna mince showed that the lightening effect produced by washing was insignificant. The result of analyses of the washed mince (table 3b) showed that it contained a high level of moisture (80%), and lower level of protein (18.72%) as compared to the unwashed mince (table 3) with a moisture content of 72.15% and protein content of 23.8 %. Further work in this direction was limited by the lack of facilities for dewatering the fish mince.

Effect of addition of raw and hydrogenated vegetable oil

The use of colour masking agents has been reported. Connell and Hardy (1982) reported the use of starches, proteins and titanium dioxide to render the fish fibres white. In the present study, vegetable oil (either in the raw or hydrogenated form) was used as the colour masking agent. Results of the organoleptic assessment (scores) are presented in table 4. In both the cooked and uncooked minces and with all levels of oil and margarine addition, texture was ranked 4.5. This means that the texture of the mince was acceptable to the panelists. The addition of vegetable oil at 4% and 6% levels appeared not to have any significant improvement on the colour of the uncooked mince as the panelists neither liked nor disliked the colour. In fact, at 8% oil addition, the colour of the uncooked mince was slightly disliked. In the cooked mince, the addition of raw and hydrogenated oil at all levels appeared to have slightly lightened the colour. The lightest degree of lightening effect was produced by the addition of 8% hydrogenated oil. This was indicated by the average score of 6.17.

There appeared to be a consensus among panelists that the addition of 4% vegetable oil (raw and hydrogenated) produced a more flavorous uncooked and cooked mince.

On average, it would appear on the basis of results obtained so far, that the addition of 4% vegetable oil (either in the raw or hydrogenated form) will produce a better and more acceptable mince. Although in the cooked mince, the addition of 4% raw and hydrogenated oils, and 8% hydrogenated oil produced similar effects, it is better to suggest the use of 4% vegetable oil when the relative cost of raw vegetable oil to hydrogenated oil is considered.

This work is significant in the sense that no work of this nature has been reported in the literature for fish mince in Nigeria. It is also important to note that the use of starches and proteins as colour-masking agents for fish produced unsatisfactory results especially after cooking (Cornell and Hardy, 1982). However, the use of vegetable oil as a colour-masking agent in the present study produced a lighter mince and a tastier and juicier cooked mince.

In view of the low lipid content which imparted a poor textural characteristic on the original mince, the addition of vegetable oil will not only help to smoothen the texture, it will also increase the calory content of the mince.

Effect of the use of dilute solution of hydrogen peroxide on the colour of tuna mince.

Problems of discoloration arise in a number of foodstuffs and one method used to overcome them is to bleach with an oxidizing agent. In view of the little success obtained from the last two operations, hydrogen peroxide, which has been used successfully (Young et al. 1980) for other species such as cod (Gadus morhua), saithe (Pallachius virens) and mackerel (Scomber scombrus), was used to bleach the tuna mince.

In all treatments in which the mince were immersed in buffer solution, a slight reduction in colour was observed. Young et al. (1980) have observed such an effect in some fish species when treated with buffer solution without the addition of hydrogen peroxide. They contended that the reduction in colour was attributed to the dissolution of some of the pigments in the aqueous phase. This may also be true for tuna because the dark colour of the mince probably results partly from pigmentation.

In the treatments in which tuna mince were immersed in buffer solutions followed by the addition of 0.75% hydrogen peroxide, it was observed that the most effective whitening effect was observed in the pH range 4-6. However, the most desirable effect was observed at pH8. It was also observed that the isolated and neutralised tuna mince at low temperature developed a light green colour after 24 hours. On the other hand, no such colouration was observed at pH8. It is difficult to account for this phenomenon but there the formation of struvite is a possibility. The most desirable and most stable mince was obtained with mild treatment with hydrogen peroxide at pH8. Treatment of tuna mince under mild conditions with hydrogen peroxide may produce whitening effects advantageous in marketing. Unfortunately, there is evidence (Young et al. 1980) that some of the protein amino acids particularly those containing sulphur are adversely affected by chemical bleaching which reduces the nutritive value of the product. Further work should be done to establish fully the quality and nutritive properties of the bleached mince and the residual peroxide concentration level in the mince.

The possible reduction in nutritive value coupled with the adverse attitude of consumers to the addition of reactive chemicals to foodstuffs may prevent the extension of this method. Furthermore, it has been said that bleaching is a form of cosmetic sophistry (Cornell and Hardy 1982) and therefore unnecessary.

With fish, in contrast to other meat products, undue attention is given to whiteness. If however, we are to make more use of our fish resources with minimal chemical processing, it is likely that some re-education will have to be carried out with the aim of showing that coloured fish flesh is at least as wholesome as white flesh and is not a consequence of spoilage.

3.3 Fish Meal from Tuna Wastes (TWFM)

Wastes generated from tuna dressing (evisceration and heading) was estimated at about 30% of the whole fish (Balogun and Talabi, 1984). Table 5 presents the proximate composition calcium and phosphorus content of fish meal produced from tuna wastes. The protein and lipid content obtained for this meal are lower than those reported for white and Herring fish meals by Talabi, B.L. Fetuga and A. Ologhobo (1980) but the ash level in TWFM is nearly double. The high ash in the TWFM suggests it would be a good source of minerals (calcium and phosphorus) in the feeding of livestock. The amounts are higher than the values reported for some meals (Miller, 1970).

Production of fish meal from tuna wastes could be a significant development in Nigeria. The bulk of fish meal used for livestock feeds in this country is imported, the supply is seasonal, fluctuate widely in price and some is of questionable quality.

Production of fish meal from tuna wastes would establish a base for local production from the varied marine fish resources of Nigeria which cannot at present be utilized for direct human consumption. Local production of fish meal will help to a great extent in conserving the country's foreign exchange, alleviate the problem of scarcity and enable the effective monitoring of the quality of fish meal that enters the market.

If locally produced fish meal from tuna wastes is to be used for livestock, its quality and biological efficiency should be assessed.

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Table 1

Yield data of smoked skipjack tuna

	Batch I	Batch II	Average
Total weight of tuna (kg)	100.60	120.00	110.30
Total weight of smoked dried tuna (kg)	30.18	39.83	35.01
Percentage yield of smoked tuna (%)	30.00	33.19	31.59

Table 3a

Yield data of tuna mince

	Yield of mince
Weight of whole tuna fish (kg)	50.50
Weight of fish after beheading and evisceration (kg)	37.96
Weight of mince produced	32.09
% of mince generated	84.20
% of mince on whole fish basis	63.54

Table 2

Proximate composition and salt content of smoked tuna (%)

Composition	Batch I	Batch II
Dry matter	89.51 ± 0.27	91.25 ± 0.31
Moisture	10.49 ± 0.26	8.75 ± 0.42
Lipid	5.98 ± 0.82	3.58 ± 0.69
Protein	71.11 ± 1.90	75.45 ± 1.96
Ash	9.88 ± 0.42	8.65 ± 0.50
Salt	6.38 ± 0.14	3.77 ± 0.12

Table 3b

Proximate composition and salt of tuna mince (%)

Composition	Unwashed mince	Washed mince
Moisture	72.15	80.00
Protein	23.87	18.72
Lipid	1.85	1.69
Ash	1.03	0.85
Salt	1.48	0.90

Table 4

Organoleptic assessment (scores) of tuna mince [a]
treated with different levels of vegetable oil

Treatment	Appearance	Texture	Colour	Juiciness	Flavour	Average Score
Uncooked						
M_1	6.00	5.50	4.50	-	6.00	5.50±0.71
T_1	5.33	5.25	4.50	-	4.67	4.94±0.41
F_1	5.00	7.00	4.33	-	4.67	5.25±1.20
M_2	6.00	5.50	5.00	-	6.00	5.63±0.48
T_2	5.44	5.13	5.14	-	4.89	5.15±0.49
F_2	5.50	6.00	5.33	-	4.03	5.42±0.49
Cooked						
M_1	-	6.00	4.67	6.00	6.17	5.71±0.70
T_1	-	5.89	5.00	5.67	4.89	5.36±0.49
F_1	-	5.67	5.50	5.00	6.00	5.54±0.42
M_2	-	6.50	5.67	6.00	5.50	6.17±0.41
T_2	-	5.38	5.38	5.56	5.11	5.49±0.33
F_2	-	5.83	6.17	5.00	6.00	5.75±0.52

M_1 = Mince + 4% vegetable oil

T_1 = Mince + 6% " "

F_1 = Mince + 8% " "

M_2 = Mince + 4% Margarine

T_2 = Mince + 6% "

F_2 = Mince + 8% "

[a] Organoleptic scores ranged from 1 to 8

i.e. 1 = Extremely dislike
8 = Extremely like
4.5 = Neither like nor dislike

Table 5

Proximate composition, calcium and
phosphorus content of fish meal
produced from tuna wastes (%)

Composition[a]	Tuna wastes fish meal (TWFM)
Protein	54.00
Lipid	5.52
Ash	26.00
Calcium	7.75
Phosphorus	4.60

[a] Average of duplicate analysis

CAUSES OF SPOILAGE OF THERMALLY PROCESSED FISH IN MOROCCO

by

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ABSTRACT

Over an 18-month period, 946 spoiled cans of fish were collected from local stores and canneries in Morocco. These included swelled, dented, deformed or leaking cans that were seized and brought to our attention.

Major container defects were found in 484 cans (51.2%) which were assumed to have resulted in the spoilage condition. Leaking seams at the manufacturer's end and droops and vees on the canner's end were the most prevalent defects (36.4% and 27.7% respectively).

Microbiological analyses were performed on a representative sample of 256 cans. Viable microorganisms were recovered from 168 cans (65.6%). The more severe the swell, the greater were the chances for recovering microorganisms. Typical leaker spoilage organisms were found in 71.9% of the cans, while 28% contained typical underprocessing spoilage organisms. Thermophilic organisms were found in association with other organisms in 50.5% of the cans.

Comparing the pH of sound cans to the mean pH of spoiled cans with and without viable organisms, autosterilization was suspected to have taken place in 11 cans.

Using vacuum testing, 15 containers were found to be leaking mostly at the canner's double seam area (46.7%) and the lap (33.3%).

The tear down inspection and double seam measurements revealed that a high percentage of containers were outside the accepted operating seam specifications. However, it was impossible to account for leakage from the individual double seam measurements. The scoring system of Davidson and Pflug (1981), was therefore used and revealed that 15.6% and 71.1% of the cans had seams of questionable and poor quality respectively, and were judged as having a potential for leakage.

Combining the microbiological analysis and the container closure evaluation data, the most probable cause for spoilage of each individual can was determined: leakage accounted for 79.8% followed by non-microbial swell (10.6%) and underprocessing (9.6%). Thermophilic spoilage may have taken place but in association with other type(s) of spoilage.

1. INTRODUCTION

The fish canning industry represents a very important sector of the Moroccan economy. About 150 000 t, representing around 30% of the total catch, are processed in over 100 canneries. Over 90% of this quantity is exported to more than 100 nations around the world (Folsom, 1977; ONP, 1983 and Zenati, 1983).

The Moroccan canning operation has used the same process for decades: the fish brought to the factories in open trucks are unloaded and piled before women workers for washing. They are then headed and gutted, rewashed and placed on conveyor belts for packing. The fish are cooked in open cans for 15 to 25 min at 108°-110°C, and allowed to cool. Certain brands then have tomatoes, olives, lemon slices or other spices and ingredients added, followed by the addition of soy or olive oil to each can. The tins are sealed, washed and cooked for 1 h at about 115°C and then allowed to cool before being rewashed and boxed. The product is usually kept for a period of at least 18 days before being inspected for possible defects. After inspection, the cans are reboxed and stored for sale. Even though the incidence of spoilage at the factory and retail levels is not known, it is believed to be highly significant.

Much of the work published on studies of Moroccan canned fish deals only with microorganisms of public health interest (Boyer et al., 1952; Oskam and Winter, 1966; Boyer, 1972; Murray, Hobbs and Gilbert, 1982; Anon. 1980). No study concerning the general causes of spoilage has been conducted. This type of work is needed to develop information on the performance of canned food sterilization processes. However, these processes have a very low failure rate of the order of 10^{-6} to 10^{-12} and it is very difficult to monitor their performance. Indeed, a random collection and examination of 100 or even 1 000 sound cans will provide little information if the failure rate is of the order of 10^{-2} to 10^{-3}, and almost no information if the failure rate is less than 10^{-3} (Davidson, Pflug and Smith, 1981). One method of carrying out such a study is to locate and examine those few cans where there has been a failure and attempt to determine the cause of that failure (Pflug, Davidson and Holcomb, 1981; Davidson, Pflug and Smith, 1981; Davidson and Pflug, 1981).

The objectives of this study were to:

- perform microbiological analysis and container closure evaluation on spoiled cans of fish obtained from local stores and canneries;
- determine the probable cause of spoilage in each case.

The overall purpose is to develop information on the performance of the canning operation in Morocco and help implement efficient quality control programmes.

2. MATERIALS AND METHODS

Arrangements were made with officers at "La Direction de la Répression des Fraudes - Ministère de l'Agriculture et de la Réforme Agraire - Rabat" to save identified spoiled cans for our project. Over an 18-month period, 807 cans were collected, by their agents from different stores in different cities of Morocco. These included swelled, dented, deformed or leaking cans that were seized and brought to our attention. We also collected 139 spoiled cans from different canneries in Safi.

All spoiled cans were characterized as to the state of swell and container damage. When major defects were found in the container, the can and its contents were discarded and disposed of, on the assumption that through handling in the store or our laboratory, microorganisms could move into the can through these defects. Therefore, we could not be certain that any microorganism found in these cans caused the original spoilage condition. The cans were then sorted and grouped by code number and state of swell. Representative samples from each lot were stored in the refrigerator until analysis was started.

Aseptic sampling and microbiological assay procedures were in accordance with those outlined in the Bacteriological Analytical Methods (US Department of Health, Education and Welfare, 1977) and elsewhere (Lecoq, 1965; Corlett, 1976; Maroc, Ministère de l'Agriculture et de la Réforme Agraire, et Ministère de la Santé, Répression des fraudes, 1984).

Prior to microbiological analysis, each can was assigned a code number and the following information was recorded on individual forms: product, ingredients, manufacturer (or distributor), can code, date manufactured, condition of the swell (flat, flipper, soft or hard swell), indicated and exact net weights.

2.1 Aseptic Sampling

The cans were washed with detergent and warm water, and air dried. They were then moved to a bench, previously sanitized with 500 ppm sodium hypochlorite solution (pH = 7 to 8), where opening and culture procedures were carried out. The top and side of each can were swabbed with 500 ppm sodium hypochlorite solution and air dried. A bactidisc cutter, sterilized in a gas flame, was used to cut a circular hole in the top, leaving at least 0.5 cm of metal next to the double seam. The can content was then homogeneized and a fish sample was removed using a sterile spoon.

The contents were checked for pH, odour, consistency and colour. Microscopic examinations to detect the presence of microorganisms were carried out using crystal violet stained preparations of the product. From each can, a portion (ca 10 g) of the product was aseptically removed and kept frozen for further confirmatory tests. Each can was then emptied and the contents sterilized and disposed of. The container was sanitized with 500 ppm sodium hypochlorite and saved for closure evaluation.

2.2 Culture Procedures

Portions (ca 1g) of the product were inoculated into each of four tubes of glucose tryptone broth (GTB) and four tubes of PE-2 medium. Two tubes each of GTB and PE-2 were incubated at 35°C for 96 hours and two tubes each at 55°C for up to 4 days (PE-2) or 10 days (GTB). Growth in GTB indicated the presence of aerobic and facultative anaerobic mesophiles (35°C) or thermophiles (55°C), while PE-2 was used to isolate anaerobic mesophiles (35°C) or thermophiles (55°C).

2.3 Characterization of microorganisms

Crystal violet stained preparations of the cultures were examined microscopically to characterize the isolates morphologically. When pure cultures of bacilli were observed on GTB at 35°C, the culture was transferred to a sporulation medium (Nutrient Agar Manganese: NAMn) and incubated at 35°C for up to 10 days. Presence of spores was then determined using wet mounts and phase microscopy or dried preparations stained using the Schaeffer and Fulton method (Leininger, 1976). If the microscopic examination revealed the presence of spore, a suspension was prepared and heat shocked (80°C, 10 min) then transferred to NAMn. Incubation was at 35°C and 55°C for up to 10 days. This procedure of spore detection was automatically used on positive GTB tubes incubated at 55°C.

Cultures of anaerobic bacilli (grown at 35°C) were inoculated into glucose tryptone agar (GTA) and freshly exhausted supplemental yeast extract agar (Pflug et al., 1979). The plates were incubated at 35°C for up to 4 days given that YEA plates were placed in a Gaspack anaerobic jar (BBL). The presence of spores was determined by using the same tests as for aerobes.

2.4 Controls

First the method efficacy was assessed using four sound cans that were sterilized in our laboratory at 121°C for 30 min. These cans were then aseptically opened and culture procedures as well as characterization of microorganisms were conducted as described above but after aseptically mixing:

- a suspension containing commercial dried yeast, Bacillus subtilis 5 230 spores and a portion of a yogurt pot, with the contents of the first can;
- a suspension of Bacillus stearothermophilus 1 518 spores with the contents of the second can;
- a suspension containing Bacillus subtilis 5 230 and Clostridium sporogenes PA 3 679 spores with the third one. The fourth can was used as received.

These experiments were carried out several times until we were able to recover automatically the microorganisms that were added.

Also, controls were always included when performing microbiological analysis on the spoiled cans. Negative controls consisted of sound cans sterilized as described above while positive controls were similar cans to which we added pure cultures of Bacillus subtilis 5 230 and PA 3 679.

All the bacilli and clostridial cultures were obtained from the culture collection of the Department of Food Science and Nutrition, University of Minnesota, USA.

2.5 Container Closure Evaluation

All the container closure evaluations were carried out at the "Institut Marocain de l'Emballage et du Conditionnement", Casablanca.

The first part consisted of testing the containers for leaks using the vacuum leak test described by Bee, DeCamp and Denny (1972). Water to a depth of 2-3 cm was placed in each container before testing. A plexiglass cover plate was placed over the opening in the can and sealed with a mastic resine. A vacuum line connected through the cover plate seal was opened. A stream of air bubbles in the water appeared at any point of leakage and was detected by shining a high intensity light into the can through the plexiglass cover.

The second part of the analysis was the tear-down inspection and seam measurement (Food Processors Institute, 1982; Etablissements Gourvenec). Three cross-sections of the double seam were cut with a power driven seam saw (fig. 1), and removed from the double seam area of the can. Each cross-section was then clamped into position in a seam projector and calipers in the base of the projector permitted direct measurement, on the projected image, of the overlap, coverhook and bodyhook.

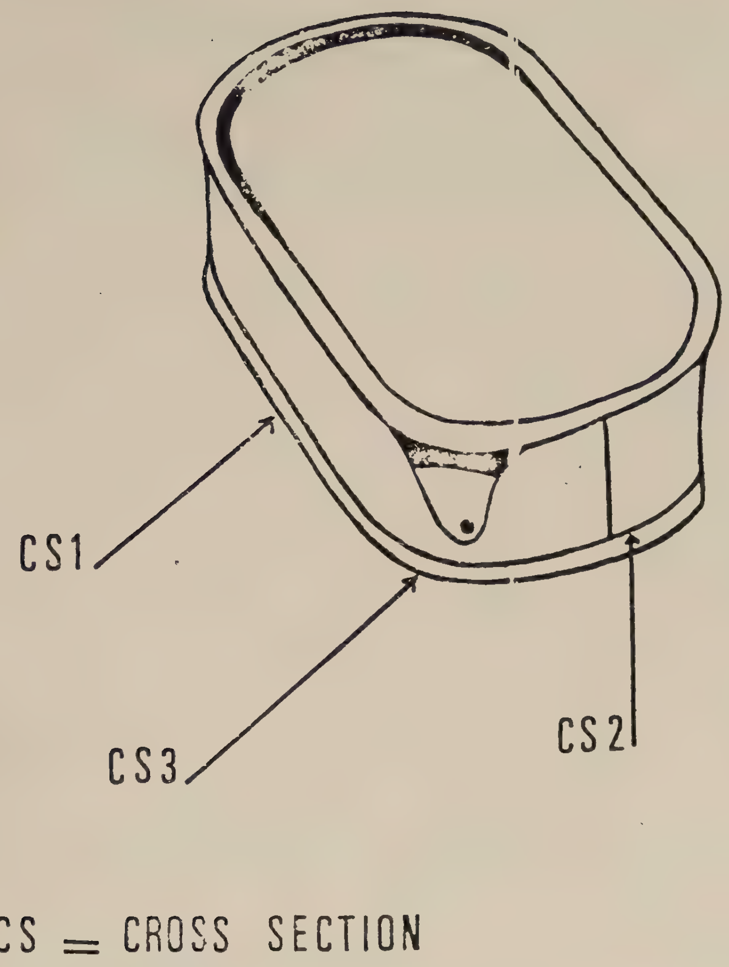

Fig. 1 Sites of the cross sections used for seam measurements

Seam tightness was judged by examining the inside of the coverhook under a magnifying glass. The tightness (or wrinkle rating) was judged on a 0-3 scale. Zero corresponds to the absence of wrinkle, 1 to a wrinkle length below one third of the coverhook, 2 between one third and one half and 3 above half the coverhook.

3. RESULTS AND DISCUSSION

Viable microorganisms were recovered from 168 cans out of 256 representing 65.6% of all the cans that were microbiologically evaluated. This is a high percentage compared with the results reported by Davidson, Pflug and Smith (1981) who found viable organisms in 46.6% of the cans they tested. However, their study included different types of food products (canned vegetables, meat, fish). The high number of cans with viable microorganisms found in our study could be due to the high protein content of the fish. Indeed, Davidson, Pflug and Smith (1981) reported that high protein food products (such as fish) are very conducive to microbial survival. Viable organisms were found in 63% of the cans containing this type of food and tested in their study.

The type of microorganisms recovered were classified by cultural characteristics (Table 1). Pure or mixed cultures of nonsporeforming mesophilic aerobes are contained in 67.2% of the cans (groups 2, 3, 4, 5 and 7). Some of these cans contained in addition thermophilic (groups 2 and 5) and sporeforming mesophilic organisms (groups 4, 5 and 7). Mixed cultures of sporeforming microorganisms (group 6) were found in 4.7% of the containers. All the above groups are traditionally known as "leaker spoilage organisms" and indicate a leakage potential in 71.9% of the containers. Pure culture of sporeforming bacilli were found in 28% of the containers (group 1 and 8). Their presence is traditionally associated with the underprocessing type of canned food spoilage. However, Johnston, Feldman and Sullivan (1963), Lynt, Kautter and Read (1975) and Davidson, Pflug and Smith (1981) have reported finding pure cultures of sporeformers that have entered the can via leakage.

Table 1

Microorganisms recovered from spoiled fish cans

Group No.	Character of the microflora	Number of samples	% of samples
1	Pure culture of sporeforming mesophilic aerobes	44	26.2
2	Mixed culture of nonsporeforming mesophilic and thermophilic aerobes	67	39.9
3	Pure culture of nonsporeforming mesophilic aerobes	21	12.5
4	Mixed culture of mesophilic aerobes	15	8.9
5	Mixed culture of mesophilic and thermophilic aerobes	8	4.7
6	Mixed culture of sporeforming mesophilic and thermophilic aerobes	8	4.7
7	Mixed culture of mesophilic aerobes and thermophilic anaerobes	2	1.2
8	Pure culture of sporeforming mesophilic anaerobes	3	1.8
TOTALS		168	99.9

Some of the sporeformers isolated in our study were also obtained from cans which showed leakage potential after container closure evaluation. However, this does not eliminate the possibility of underprocessing since it is known that microorganisms do not always enter into containers that have leaks (Maunder, Folinazzo and Killoran, 1968).

The effect of the state of the swell on the recovery of microorganisms was also examined (Table 2). There appeared to be a relationship between the state of the swell and whether microorganisms were recovered from the food product or not. The more severe the swell, the greater were the chances for recovering microorganisms. This confirms results reported earlier by Davidson, Pflug and Smith (1981).

Table 2

Effect of the state of swell of the can on recovery of microorganisms

Type of swell	Total number of swelled cans	Number of swelled cans with viable microorganisms	% of swelled cans with viable microorganisms and with the specific type of swell
Flat	46	30	65.2
Flipper	43	30	69.2
Soft	48	42	87.5
Hard	67	66	98.5
TOTALS	204	168	

The pH of the food in the spoiled cans with no viable microorganisms (negative) was compared to the pH of the spoiled product with viable microorganisms (positive) and with the pH of the normal product as a basis for estimating if autosterilization has taken place (Table 3). There was no significant difference (p = 0.05) between the average of these 3 pH values. We believe this to be due to the fact that the proteins, present at high levels in fish, acted as buffer during microbial growth. If the pH of an individual negative can product was within or below the 95% confidence interval of the observed pH of the positive product, this would be evidence to suggest that the swell was due to microbial growth but that autosterilization had occurred. Conditions which suggested no microbial growth were found when the pH of individual negative cans was within the pH range of the normal products, Davidson, Pflug and Smith (1981).

Table 3

Effect of the product pH on recovery of microorganisms

Composition	Total samples			Samples with viable microorganisms			Normal product	
	No.	Mean pH	95% CI pH	%	Mean pH	95% CI pH	Mean pH	95% CI pH
Sardines in oil	148	6.23	6.14-6.32	65.5	6.27	6.18-6.36	6.22	6.12-6.32
Sardines in oil and spices	39	6.09	6.04-6.14	76.9	6.09	6.04-6.14	6.14	6.01-6.27
Sardines in tomato sauce	26	5.93	5.83-6.03	46.1	5.63	5.42-5.84	5.94	5.77-6.11
Sardines and tomatoes and oil	10	6.10	6.02-6.18	40.0	6.10	6.02-6.18	6.10	5.6-6.60
Sardines in olive oil	9	6.41	6.26-6.56	100.0	6.30	6.15-6.45	6.20	6.10-6.30
Tuna "au naturel"	3	5.73	5.70-5.75	66.7	5.70	5.68-5.72	-	-
Tuna in olive oil	1	6.27	-	100	6.27	-	-	-
Tuna in oil	1	-	-	0	-	-	-	-
Mackerel in oil	1	6.20	-	0	-	-	-	-
Others	18	6.01	5.90-6.12	72.2	6.27	6.18-6.37	6.22	6.12-6.32

Based on this reasoning, we found that autosterilization may have taken place in 11 cans. However, for other negative spoiled cans, it was difficult to conclude because their pH was within the 95% CI of the pH of the positive product, and within the pH range of the normal product.

Before microbiological analysis, the spoiled cans were examined for holes or defective seams. Of the 946 cans collected, 484 (51.2%) had major defects (Table 4). Leaking seam at the manufacturer's end and droops and vees on the canner's end were the most prevalent defects (36.4% and 27.7% respectively). Fifty percent of the cans had major defects on the canner's end and 50% on the manufacturer's end. This high percentage of cans with major defects suggest a possibility of lack or inefficient quality control of the seaming operation by both the can manufacturers and the canners. Moreover, 16 cans showed evidence of brutal damage during shipping, and 4 cans were strongly corroded.

All the microbiologically evaluated cans were vacuum tested (Table 5). It was found that 15 cans (5.9%) leaked, compared to 71.9% typical leaker spoilage found in microbiological testing. The amount of cans leaking at the canner's double seam area was 46.7%, at the lap 33.3% (canner's end) and the remaining 20% at other places in the container. These data suggest that the vacuum test is not a good measure of leakage. This might be because it is more effective in detecting leaks at points on the container other than the double seam. Indeed, Pflug, Davidson and Hocomb (1981) have reported that the path that contamination must use to enter a samitary can is much longer at the double seam than through a hole.

Also, if food plugged a hole in the double seam it might be virtually impossible to remove it by a washing procedure. The pressure applied to a leakage path in the vacuum leak test has a much better chance of unplugging a simple hole than clearing a blocked path through a seam.

Table 4

Types of major defects, externally visible, found in spoiled cans of fish

Defect	Number of cans	Percentage
Canner's end		
Droops and vees	134	27.7
False seam	23	4.8
Fractured seam	18	3.7
Leaking seam	5	1.0
Leaking code stamp	2	0.4
Unknown	60	12.4
Manufacturer's end and side seam		
Leaking seam	176	36.4
Hole in metal	35	7.2
Leaking side seam	30	6.2
Can body	1	0.2
TOTAL	484	100.0

Table 5

Area of the container where leakage occurred as determined by the vacuum test

Area of leakage	Number of samples	Percentage
Canner's end		
Lap	5	33.3
Double seam	7	46.7
Manufacturer's end		
Lap	1	6.7
Double seam	2	13.3
TOTAL	15	

The mean measurements (and standard deviation) of the bodyhook coverhook and overlap are shown in Table 6. These values were compared with generally accepted operating seam specifications (Table 7). Because of the shape of the can (figure 1), it was felt that the potential for obtaining seam measurements outside of the specifications was different for the 3 cross sections. Therefore, all the measurements (not the mean) were used. A high percentage of cans had seam measurements outside the specifications suggesting again inefficient control of the seam operation in the canneries. However, this was judged to provide only partial indication of the potential for a seam to leak. Indeed, analysis of individual measurements does not take into account the interactions of the several parts of the seam. Therefore the scoring system developed by Davidson and Pflug (1981) was used. In this system, tightness is judged to be the most important seam attribute, followed by overlap and finally coverhook and bodyhook which are judged of equal importance (Table 8). Assigning values to actual measurements was done by using half the standard deviation of the overlap and bodyhook measurements as steps between scores. The ideal targets for the seam measurements were used as starting points.

A can seam that had all dimensions within the standard range, i.e., within one half the standard deviation of the target measurements, would have a score of 10 (wrinkle = 3, overlap = 3, coverhook = 2 and bodyhook = 2). Small scores are indicative of better seams, while large scores indicate poorer seams. The following system was used in judging the overall quality of the seams: Class I, 12 points (meet specifications), Class II, 12-14 points (seams of questionable quality) and Class III, 14 points (seams of poor quality).

Table 6

Mean and standard deviation (in millimetres) for areas of the canner's end double seam

Seam area	Mean			Standard deviation			Average of measurements for all 3 sections	
	CS1	CS2	CS3	CS1	CS2	CS3	Mean	Standard Deviation
Body hook	1.90	1.81	1.86	0.19	0.24	0.23	1.87	0.25
Cover hook	1.91	1.75	1.73	0.10	0.25	0.24	1.79	0.23
Overlap	1.32	1.07	1.11	0.22	0.30	0.29	1.16	0.29

Table 7

Percentages of canner's end seam measurements which were outside the specification limits

Seam area	Percentage
Bodyhook	37.2
Coverhook	52.2
Overlap	60.2
Wrinkle	58.0

Table 8

Limits of measurements and corresponding scores used to score can double seams

Wrinkle (tightness)		
	Rating	Score
	0	1
	1	3
	2	6
	3	9
Overlap (Target = 1.25 mm)		
	Measurement (mm)	Score
	1.40	1
	1.40-1.11	3
	1.10-0.97	5
	0.96-0.83	7
	0.83	9
Bodyhook and coverhook (Target = 1.85 mm)		
	Measurement (mm)	Score
	1.98	1
	1.98-1.72	2
	1.71-1.59	3
	1.58-1.46	4
	1.46	5

It was found that 13.3% had seams that met the specifications, while 15.6% and 71.1% had seams of questionable and poor quality respectively. A total of 86.7% had seams in the questionable or poor quality classification suggesting a potential for leakage. These results compare favorably with those of the microbiological analysis performed on these cans.

Combining the results of the microbiological analysis, container closure evaluation and all the other pertinent information collected, the most probable cause for spoilage of each individual can was determined (Table 9). Leakage accounted for 79.8% followed by nonmicrobial swell (10.6%) and underprocessing (9.6%). Leakage was therefore a major cause of spoilage of canned fish in Morocco at the time of this study. To reduce this problem, we believe more emphasis needs to be placed on:

- quality control in can manufacture;
- quality control and proper equipment setting in the canning plant seaming operations;
- better control of the chlorination of cooling water.

Moreover, 89% of the cans that showed a possibility of underprocessing contained fish packed in oil. This is possibly because of "the fat protection effect". Indeed, several workers (Barlett and Kline, 1913; Dickson et al., 1925; Lang and Dean, 1934; Molin and Snygg, 1967; Zakula, 1969; Senhaji and Loncin, 1977; Senhaji, 1977) have reported that when lipids materials are included in the suspending medium, microorganisms exhibit an increased resistance to thermal treatment. As a result there has been some evidence that spores and vegetative cells may survive exposure to temperatures used in the conventional heat sterilization processes of foods.

Also, after investigations on the thermal processes actually applied in Moroccan fish canneries, it was found that the same process is used regardless of the can content. This is not the case in canneries of other countries where products (such as fish) packed in oils undergo a more severe thermal process than the same food products with different formulations, in order to account for the protective effect of the oil (NFPA, 1982). We believe this to be a very crucial problem that needs full investigation because of the possibility of the presence and survival of Clostridium botulinum spores that can grow and produce toxins in this low acid flow.

At the present time, a study on the effect of vegetable oils on the survival of clostridial spores to thermal stress is under way in our laboratory.

Table 9

Probable causes for spoilage of fish cans

Cause of spoilage	Number of samples	Percentage
Leakage	150	79.8
Nonmicrobial swell	20	10.6
Under-processing	18	9.6
Thermophilic organism	0	0.0
Total	188	100.0

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DEVELOPMENT OF SALTED MEAT ANALOGUES FROM THE MINCE OF *Trachurus trachurus*

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ABSTRACT

Fish mince, containing up to 20 percent salt (sodium chloride), has successfully reformed into fish-meat analogues using a sodium alginate and calcium chloride gelling system and an alternative process involving sodium carboxy methyl cellulose and basic aluminium acetate. The unsalted meat analogues could be subjected to high temperature salting and alternative salting step. The two salting processes were found to lower the analogues' microbiological load to a level which confers product stability.

1. INTRODUCTION

Most of the published work on fish-meat analogues had been on products meant for refrigerated storage. Consequently, the need for the use of stabilizers against microbial damage has not been examined. In studies on the refrigerated storage of analogues, rheological and flavour characteristics have been the primary considerations.

Very little has been published on the flavour of fish-meat analogues. In the work by Lee and Toledo (1979), it was found that the textural characteristics of mince could be strongly affected by the addition of sodium chloride, polyphosphate and by the mixing time, the mince moisture content and cooking temperature. No empirical relationship was established among these factors and the final product was found to be texturally unacceptable. On the basis of their previous work on mince, and bearing in mind the rheological problems earlier encountered, Lee and Toledo (1979), determined the process requirements and formulations necessary to fabricate a coarse-textured smoked fish analogue using Spanish mackerel mince as their starting material. The problem of unacceptable texture reported earlier was solved in this work by the application of 12-g shortening/100 g of fish mince and soy protein fibre (SPF) at a ratio of 15:85 SPF/fish mince using a dual stage mixing process. It appeared from their report that the use of the additives plus the mixing processes enabled them to arrive at a texturally acceptable product. No significant effort was made at stabilizing the product against microbial damage except that heating was employed at one stage of the process, though at a level that would not guarantee microbial stability. Perhaps a more useful attempt to stabilize and produce analogues from fish mince was that reported by Bello and Piggot (1979). In their studies, they incorporated texturized vegetable protein (TVP), into their mince. Unfortunately, they failed to show the rheological effect of the incorporation of the TVP on the final product.

In general, published research efforts have tended to concentrate on the use of either vegetable proteins or solubilized proteins (usually based on the fundamental work of Duerr and Dyer (1952), as binding matrixes.

In the present study, mince from gutted horse mackerel has been subjected to reformation into analogues using sodium carboxymethyl cellulose and sodium alginate with the objective of making a product which is stabile against microbial damage and with acceptable rheological properties.

2. MATERIALS AND METHODS

2.1 Binding and Reformation of Unsalted Mince with Sodium Alginate

Two kilogrammes (in quadruplicate) of mince obtained by mechanical meatbone separation, using the Baader 694, were mixed with sodium alginate (supplied by Alginate Industries Ltd., UK, as Manucol DH), at varying concentrations ranging from 0.25 to 2% of the mince. Mixing was for 5, 10 and 15 min. The ensuing mass was then reformed into meat analogues using a hand-operated former which had been premoistened with 5% calcium chloride solution. After reformation, the analogues were again given a liberal irrigation of 5% calcium chloride solution. The analogues were then washed in clean, fresh water, care being taken to separate the pieces produced by the different mixing regimes. The analogues were then weighed and transferred to casserole dishes and steam-cooked for 30 min in a steam cooker. They were drained and weighed again to obtain the weight of the released liquor.

2.2 Binding and Reformation of Unsalted Mince (into Analogues), Using Sodium Carboxymethyl Cellulose

Two kilogrammes portions of Baader-separated mince were mixed with sodium carboxymethyl cellulose (supplied by Hercules Powder Company, London, as Blanose 7HF), in varying concentrations ranging from 0.25 to 2% of the mince. Mixing times ranged from 5 to 15 min and reformation was accomplished using a hand-operated former. Gelling of the cellulose was achieved by means of basic aluminium acetate added at the level of 20% of the cellulose concentration.

After reformation, the pieces were weighed, steam-cooked for 30 min and weighed again. The liquor was drained and the difference was taken as the juice released.

2.3 Incorporation of Salt (Sodium Chloride) into Fish-Meat Analogues

Two processes were employed. In process I, 5, 10 and 20% sodium chloride were added directly to the mince during the mixing stage with the gelling agent and mixed for 5, 10 and 15 min in a Kenwood mixer at constant medium speed (speed 5). The same equipment as described earlier was employed for the reformation into analogues.

In process II, reformed pieces using 0.5% sodium alginate or 0.25% sodium carboxymethyl cellulose were made which were then separated into five batches and subjected to the following treatments.

(a) High temperature brining of raw analogues using saturated brine

A saturated brine solution was prepared with an excess of salt crystals in the bottom of an aluminium container with a capacity of 20 litres of brine. The container was brought to the boil (B.P. 109°C), and the reformed pieces were then placed in it. Boiling was continued for 60 min and samples were taken periodically. Samples were immediately analysed for sodium chloride and moisture contents by modified AOAC methods (1975).

(b) High temperature brining of cooked analogues using saturated brine

Analogues were cooked for 15 min in a steam cabinet. They were then brine treated (as in (a)), and later analysed for moisture and salt contents.

(c) High temperature brining of analogues using 17% brine

A 17% brine solution was prepared and the brine treatment (as in (a)), was repeated.

(d) Room temperature brining of analogues using concentrated brine

Brining was carried out at +30°C for four days using 17% brine solution. Daily analysis for sodium chloride and moisture were carried out.

(e) Room temperature dry-salting of analogue

Experiment (d) was repeated, but with dry salt replacing the brine at a salt/analogue ratio of 3:1.

(f) High temperature dry-salting of analogues

Finally, reformed pieces were treated as in (e), but using a slight modification. The pieces were packed in retortable pouches (supplied by Metal Box, UK), and heated at 100°C in dry salt for 60 min. Samples were removed every 15 min for analysis.

2.4 Textural Characteristics of Salted and Unsalted Analogues

The textural characteristics of salted and unsalted analogues were determined by the single point measurement technique. For this purpose, a transverse cut is made in the median of each analogue. A single point penetrometer (supplied by Higges, West Germany), was applied to the cut surface. The force required to deform the cut surface is recorded in grammes of force.

2.5 Differentiation of Fibres in Developed Analogues

This was done by the modified one step Trichome Stain method of Sweet, Melean and Puchtler (1968), as follows:

Five-millimetre thick sections of frozen, freshly prepared analogues were made using a standard laboratory microtome. These were then immersed in deionized water and later in a solution of saturated aqueous solution of picric acid - commercial formalin - glacial acetic acid 15:15:1, mixed shortly before use, for 1 h at approximately 56°C.

The sections were again washed in water until they were decolorized and then stained for 1 min in trichrome solution. Rinsing followed in 1% aqueous acetic acid solution for 30 sec after which they were dehydrated in one change of 95% alcohol and three changes of absolute alcohol. Finally, they were cleared in xylene, mounted immediately and photographed.

2.6 Microbiological Examination of Analogues Containing Over 15% Sodium Chloride Total Viable Count of Fresh Mince and Salted Analogues

The procedure was that of Bean (1976).

One hundred grammes of fish pieces were homogenized aseptically in 400 ml of sterile chilled phosphate buffer. This was placed at 4°C for 30 min to allow the particulate matter to settle and the bubbles to disperse. Serial dilutions of the homogenate were then prepared with 1 ml pipettes, using phosphate buffer as the diluent. Using 0.1 ml pipettes, each dilution is dropped on the surface of a nutrient agar plate. The plates are numbered according to the dilutions plated out on them and it was found necessary to make duplicates or triplicates of each dilution on the plates. These plates were incubated at two different temperatures, namely 37°C and 20°C, to examine the viability of the organisms at the various temperatures. Counts were made after 18-24 h incubation and also repeated after 48-h incubation.

2.7 Examination for Clostridium Welchii in Analogues

The media for the cultivation of Clostridium was cooked meat broth. This medium is suitable for the growing of anaerobes in air and other samples.

The procedure used was that reported in the standard procedures for bacteriological analysis - Environment Canada, Inspection Branch (1972).

The fish analogue sample was homogenized in a pre-sterilized Waring blender in phosphate buffer solution and incubated in Robertson's cooked meat broth for six days at +30°C. One-millilitre samples were then plated out on blood agar plates and incubated for three days at +30°C. Isolates were then picked and plated out on the lactose egg yolk agar and incubated for 24 h at 30°C, after which colony appearances should be observed. (All agar plates were supplied by Oxoid, UK).

2.8 Examination of Analogues for the Occurrence of Staphylococcus aureus

The procedure was that of Harigan and McCance (1976). One hundred grammes of duplicate samples of analogues were weighed out and homogenized in 400 ml of chilled sterile phosphate buffer. They were then placed at 4°C for 30 min to allow the particulate matter to settle and the bubbles to disperse. Serial dilutions of the homogenates were made and 0.1 ml of each transferred to duplicate plates of poured Baird-Parker's medium. The inoculum was spread evenly over the surface of the plates with a sterile, bent glass rod. They were then incubated for 48 h at +37°C.

3. RESULTS

3.1 Process I Experiments

The purpose of these experiments is to establish the optimum level of binders (sodium alginate and sodium carboxymethyl cellulose), which could yield the highest levels of liquor release (minimum level of moisture in the analogue), and a desirable texture. Texture in this regard was measured in terms of penetrometer readings.

3.2 Binding of Mince with Sodium Alginate

The results of the experiments in which sodium alginate was employed as a binder at concentrations ranging from 0.25% to 2% are summarized in Figure 1. The results show that in the absence of sodium chloride juice release was inversely proportional to sodium alginate binder concentration up to a concentration of 0.75%. In the presence of 20% sodium chloride, an inverse relationship appeared to exist up to 1.25% sodium alginate concentration. Of the three mixing regimes, an insignificant difference exists between 5 and 10 min of mixing, whereas a mixing time of 15 min gave a slightly higher level of juice release in the presence of 20% sodium chloride. Mixing time (5-15 min), did not appear to influence the amount of juice release in the analogues which did not contain added sodium chloride.

The results of penetrometer measurements on the analogues which did not contain sodium chloride are shown graphically in Figure 2. Here the effect of mixing regimes was significant at 0.25% and 0.50% binder concentration. At 0.75% binder concentration, mixing time is not significant. The analogues exhibited distinct textural differences under these mixing regimes and indeed between 0.75% and 1.5% binder concentration, the textural characteristics of the analogues (measured by penetrometry), was a function of the binder concentration. Between 1.5% and 2% binder concentration, no textural differences were apparent. Taken together with the data on juice release, it is possible to conclude that increased alginate binder concentration results in reduced moisture loss which, in turn, determines the degree of hardness in the unsalted analogue. It is equally relevant, therefore, to assume that some aspects of the textural characteristics of the unsalted analogue is a function of moisture content. Mixing time appears to have an independent role in the texture/juice release relationships since one would expect mixing to be of little significance in the textural characteristics as it was in the juice release. A similar situation appears to exist in the analogues containing 20% sodium chloride.

Penetrometer results on 20% salted analogues are shown in Figure 3. Five minutes of mixing were found to produce consistently high penetrometer values at binder concentrations ranging from 0.25% to 1.75%. Ten minutes of mixing yielded a linear situation, while 15 min of mixing gave an equilibrium between 0.75% and 1.5% binder concentration, followed by a rapid increase beyond 1.5% binder concentration.

When the binder concentration was fixed at 0.5% and the sodium chloride concentration varied from 5% to 20%, juice release was found to be a function of the salt concentration (see Table 1). The correlation coefficients show that mixing for 5 or 10 min released the same amount of juice, whereas the higher value for 15 min of mixing shows a greater effect on the juice release. Analogues containing 20% sodium chloride showed a strong correlation between penetrometer readings and juice release in respect of 5 and 10 min of mixing (see Table 2). For 15 min of mixing, the correlation coefficient of +0.62 suggests that a different mechanism determines textural characteristics when mechanical force is applied to the system for a prolonged period.

Table 1

Percent of juice release in salt-treated mince
reformed with 0.5% sodium alginate
in relation to mixing time

NaCl level in mince	% juice release		
	Mixing time (min)		
	5	10	15
5%	11.9	8.6	7.0
10%	23.6	21.9	18.9
15%	26.2	26.3	29.1
20%	29.7	29.9	35.1
r[a]	+0.93	+0.94	+0.99

[a] Correlation coefficient

Table 2

Penetrometer reading (g) in salt-treated mince reformed with 0.5% sodium alginate in relation to mixing time

NaCl Level in mince	Penetrometer readings (g)		
	Mixing time (min)		
	5	10	15
5%	160	140	120
10%	360	230	200
15%	365	230	200
20%	380	250	210
r[a/]	+0.82	+0.86	+0.62

[a/] Correlation coefficient

The difference between the juice release in analogues containing 5% and 10% sodium chloride is high, and it appears that within this range, some drastic phenomenon has taken place which resulted in the inability of the mince to retain juice.

When sodium chloride was introduced at the beginning of the mixing process, the mince tended to emulsify, thereby making reformation impossible. At 5% and 10% sodium chloride levels, this type of emulsification was somewhat delayed (delay time not measured). In order to be able to introduce higher levels of sodium chloride, it was found necessary to add the sodium chloride after the sodium alginate had been thoroughly mixed into the mince.

3.3 Binding of Mince with Sodium Carboxymethyl Cellulose

Results presented in Figure 4 on the juice released show little variation in relation to cellulose concentrations at 0.25% and 0.5% in unsalted analogues and an equilibrium is apparent beyond 1% cellulose concentration. The penetrometry (see Figure 5) results are similar to the juice release data. In general, low levels of binder yielded high levels of juice release, indicating an inverse relationship. The effect of mixing time on the juice release was not significant.

In the 20% salted analogues (see Figure 6), 0.25% and 0.5% cellulose showed little difference in their juice release and gave the highest levels. Release decreased with increasing binder concentration up to 1.25% level when equilibrium was reached. The effect of binder concentration on the resistance to applied force in the 20% salted analogue was not well defined. Resistance to applied force appeared to be a function of decreasing binder concentration and increasing mixing time up to 0.75% binder concentration. Beyond this level, 5 min and 15 min of mixing were practically the same with equilibrium being achieved at 1% cellulose level. When the juice release data and the penetrometer readings are taken together, using 0.25% cellulose at 5 min of mixing appeared to produce optimum conditions.

3.4 Process II Experiments

Essentially, these involve the modification of the salting step so that unsalted analogues are prepared and are then sujected to a hot brining step after reformation. The criterion for an optimum condition of salting was a short time for the achievement of salt concentration of approximately 18% - a level which will inhibit most micro-organic growth at intermediate moisture level.

Results of the experiments can be grouped into two, namely those in which high temperature brining and those in which room temperature brining were employed. Under the high temperature brining conditions, salt equilibrium was not reached even after the salt uptake attained a level of 18% within a period of 40 min in both the blanched and unblanched analogues (see Figure 7). When the unblanched analogue was packed with dry salt in a pouch and then retorted at 100°C, a salt uptake of 10% was attained in 60 min, showing a lower level of salt uptake than those in which the analogue was in direct contact with brine. A lower brine strength of 19% was tried and maximum uptake was reached at only 8% salt in 60 min (see Figure 8). Results of cold brining experiments are shown in Figure 9. Maximum uptake of 16% salt was achieved in three days, while in 15% brine at the same room temperature, a maximum uptake of 11% salt was achieved in one day. The level equilibrated thereafter, unlike in the dry salt in which uptake continued for three days up to its maximum of 15%, after which the salt level tended to fall.

The results show that high temperature and the physical state of the salt are two important factors in the rapid salting of the analogue. When the results are related to the previous theoretical considerations on salting, it becomes obvious that a high value of the salt uptake was attained purely as a result of the elevated temperature of brining. It is in the same light that the aspect relating to the nature of the salt medium can be viewed. Thus, where dry salting was employed, the salting time was longer than when salt solution was employed. The explanation is that sodium chloride in solution is more mobile than in the dried form. Consequently, it is only when solubilization of the sodium chloride by the moisture of the fish takes place that salt migration into the analogue could commence.

3.5 Fibre Distribution in Developed Products

Fibre distribution in the reformed pieces was influenced by the two salting processes. Thus, in Process I involving direct addition of dry salt to the mince, short fibres were observed, while Process II tends to produce long fibres.

3.6 Microbiological Examination of Analogues

Results of the microbiological examination of the analogues from the two processes are presented in Table 3.

The low total viable counts at both 20°C and 37°C show that the microbiological stabilization procedures were satisfactory. There was neither *Clostridum welchii* nor *Staphylococcus aureus* in the analogues.

4. DISCUSSION

Consumer demand for *Trachurus trachurus per se*, is low because of the bone content and unattractive appearance. In approaching the problem of its utilization it was found necessary to develop a number of products from a deboned intermediate material which will have enhanced consumer appeal. Thus, the fish was subjected to a process of mechanical separation of the meat (mince) from the bone and the skin. The mince was then reformed into analogues and subjected to two processes of salting as a means of stabilizing them against microbiological deterioration and spoilage. The results from this study on the development of the stable analogues confirm that the process is feasible.

In the development of the analogues, advantage was taken of the production of rigid gels by means of the two reactions:

(1) $\text{Na alginate} + CaCl_2 \longrightarrow \text{Ca alginate} + Na^+$

(2) $\text{Na carboxymethyl cellulose} + Al^{3+} \longrightarrow \text{Al carboxymethyl cellulose}$

In respect of reaction (1), Wylie (1976), established that the formation of calcium alginate gels facilitates a spontaneous production of skin on analogues, thereby allowing reformation and, that subsequent setting took place inside the reformed analogues. Reaction (2) has never been examined as a possibility in the food industry, although Mitchell (1981), has shown the mechanisms involved with proteins, while Debutts, Hudy and Elliot (1957), have described the effect of mechanically applied force on the behaviour of cellulose fibres. They showed a shortening of fibre lengths and distribution with increasing applied force. Basic information on the characteristics of the two binders has consequently limited an understanding of some of the phenomena observed in this study.

The effect of sodium chloride on the mince is significant. Proteins are known to denature in the presence of high salt concentrations. In the work by Duerr and Dyer (1952), the critical point of denaturation by salt in cod was observed at the salt level beyond which rapid salt uptake and moisture release took place. This level was shown to be close to 10%. In the present work, the increase in juice release (see Table 1), in respect of 5% and 10% added salt, appears to be in accordance with the results of the work of Duerr and Dyer (1952).

This is in spite of the fact that there are differences in the experimental conditions of the present work and their work. These differences are as follows:

(a) no matrix binder was employed in their work,
(b) the fish was not in mince form,
(c) there was no heating.

In spite of the differences it is obvious that between 5% and 10% salt levels some drastic phenomenon was taking place that can be regarded as very similar to the salt denaturation proposed by Duerr and Dyer (1952).

Table 3

Bacteriological analysis - fish analogues
total viable bacteria count at 37°C (TVC)

Process type	Mean total viable count (TVC) at 37°C (colonies/g)
Process 1 with alginate	1.5×10^3
Process 1 with cellulose	1.5×10^3
Process 2 with alginate	5×10^2
Process 2 with cellulose	1.5×10^3
Untreated raw mince	5×10^8

TOTAL VIABLE COUNT BACTERIA AT 20°C

Process type	Mean TVC at 20°C
Process 1 with alginate	1.5×10^3
Process 1 with cellulose	1.5×10^3
Process 2 with alginate	5×10^2
Process 2 with cellulose	5×10^2
Untreated raw mince	5×10^7

Very few earlier attempts at reforming salted mince employed binding additives apart from salt solubilized proteins. In the work by Bello and Piggot (1979), binders were employed in the binding of fish proteins containing relatively low levels of sodium chloride (normally added for taste), and the consumer-response tests were the only measure of optimum process conditions. This approach is subjective and is often beset with non-reproducible factors which are related to the fact that subjects may sometimes by measuring different textural attributes. It was on the basis of this consideration that penetrometry was employed to objectively describe one aspect of the textural characteristics of the analogues. When sodium chloride was introduced at the beginning of the mixing process, it was observed that the mince tended to form emulsions, particularly at high salt levels. In this regard, there appear two possibilities. These are:

(a) solubilization of the fish proteins in accordance with the findings of Duerr and Dyer (1952);

(b) the reversion of the reaction between calcium ions and alginate ions in the presence of high sodium chloride levels (Wylie, 1976), in accordance with the equation below:

$$2\text{Na Alg} + \text{CaCl}_2 \underset{\substack{\text{excess}\\ \text{NaCl}}}{\rightleftarrows} \text{Ca(Alg)}._2\text{(Gel)} + 2\text{NaCl}$$

The solution to the above problem involved the delay of addition of sodium chloride until the sodium alginate had been thoroughly mixed into the mince. It is assumed that by so doing, the alginate would have been bound to the protein molecules to the extent that they would not be able to participate in the reversion reaction above. The introduction of a blanching step, as was described in the results, may have enabled the gelling rate to be considerably increased far in excess of the reversion rate. Coagulation of the salt solubilized protein might also have assisted in providing a matrix with binding characteristics in accordance with the mechanism suggested by Mac-Farlene, Schmidt and Turner (1977).

When the results were taken together, the rheological property of the analogues was found in this study to be governed by the level of liquor released during the blanching step, the binder concentration and the mixing time.

The two methods of achieving microbial stability revolved round the use of sodium chloride. This is not novel, as the application of sodium chloride for preservation of animal flesh is as old as history. What appears to be significant, therefore, in the results of this work is the mode of application of the salt, and the approach developed for preventing a reversal of the gelling process in the presence of high sodium chloride concentration. This approach, discussed earlier, involves in the case of Process I the introduction of sodium chloride after the sodium alginate has been thoroughly mixed into the mince. Secondly, a blanching step was also involved as a means of accelerating the gelling process and coagulating salt-solubilized proteins.

In the case of Process II, the analogues were introduced into hot brine. The high temperature of the brine enabled a spontaneous gelling process and protein coagulation to take place, which combined to prevent reversion of the gel to the sodium form.

The results of the mircobiological studies show that the salt treatment reduced the quantity of the organisms to a level of microbiological stability at ambient temperature. There was no difference in the effects of the salt treatment on the microbiological load of the salted analogues.

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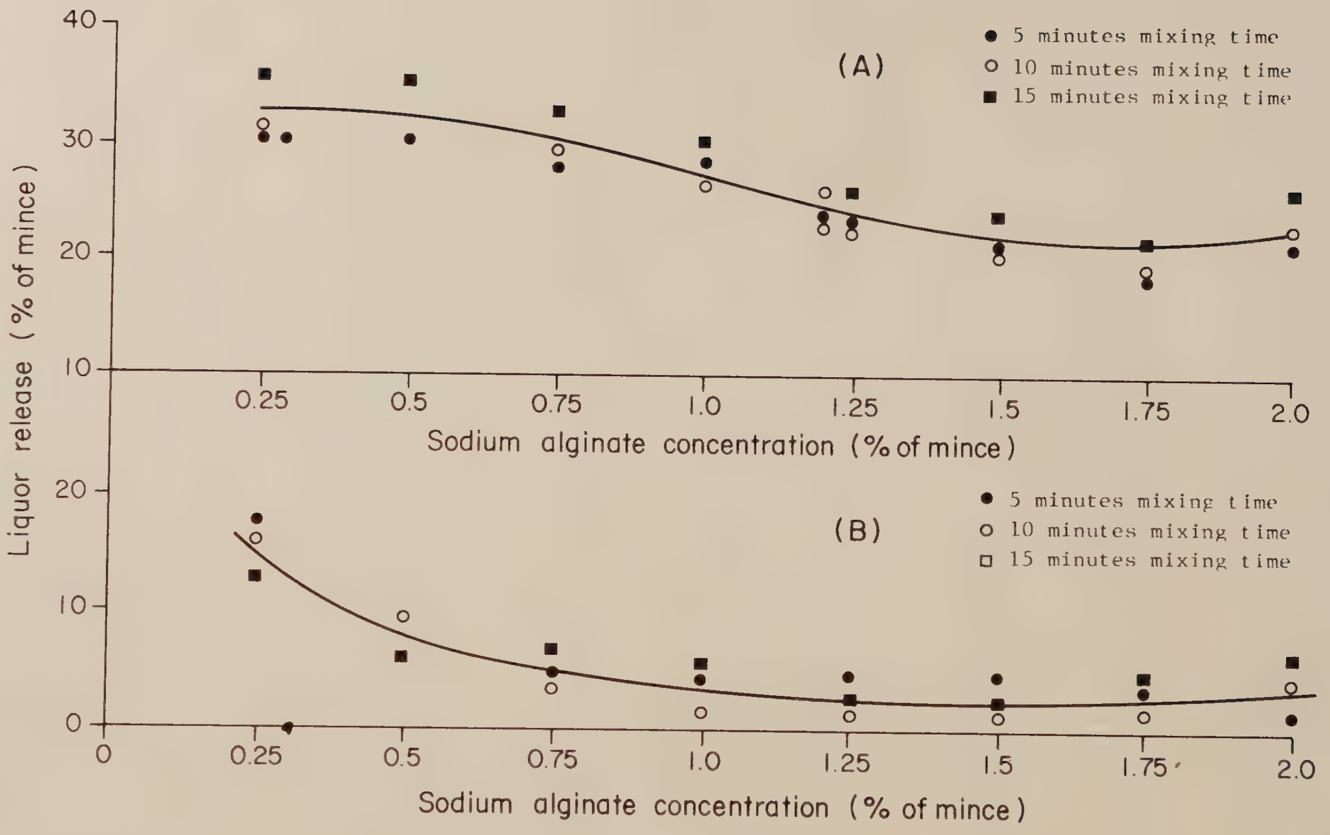

Figure 1 Percent of liquor release in relation to mixing time and sodium alginate binder concentration at A: 20% dry salt level; B: unsalted

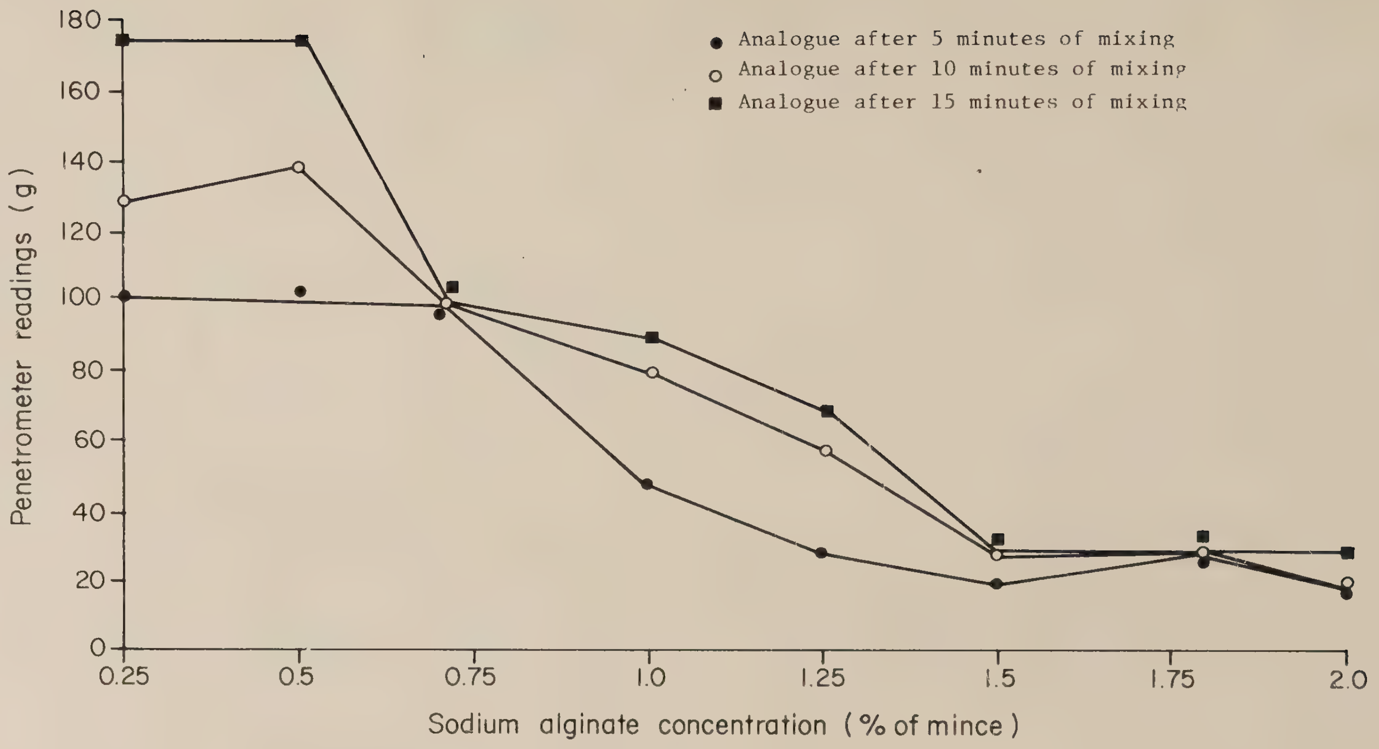

Figure 2 Resistance to applied force (measured as penetrometer (g)) in relation to sodium alginate binder concentration and mixing time

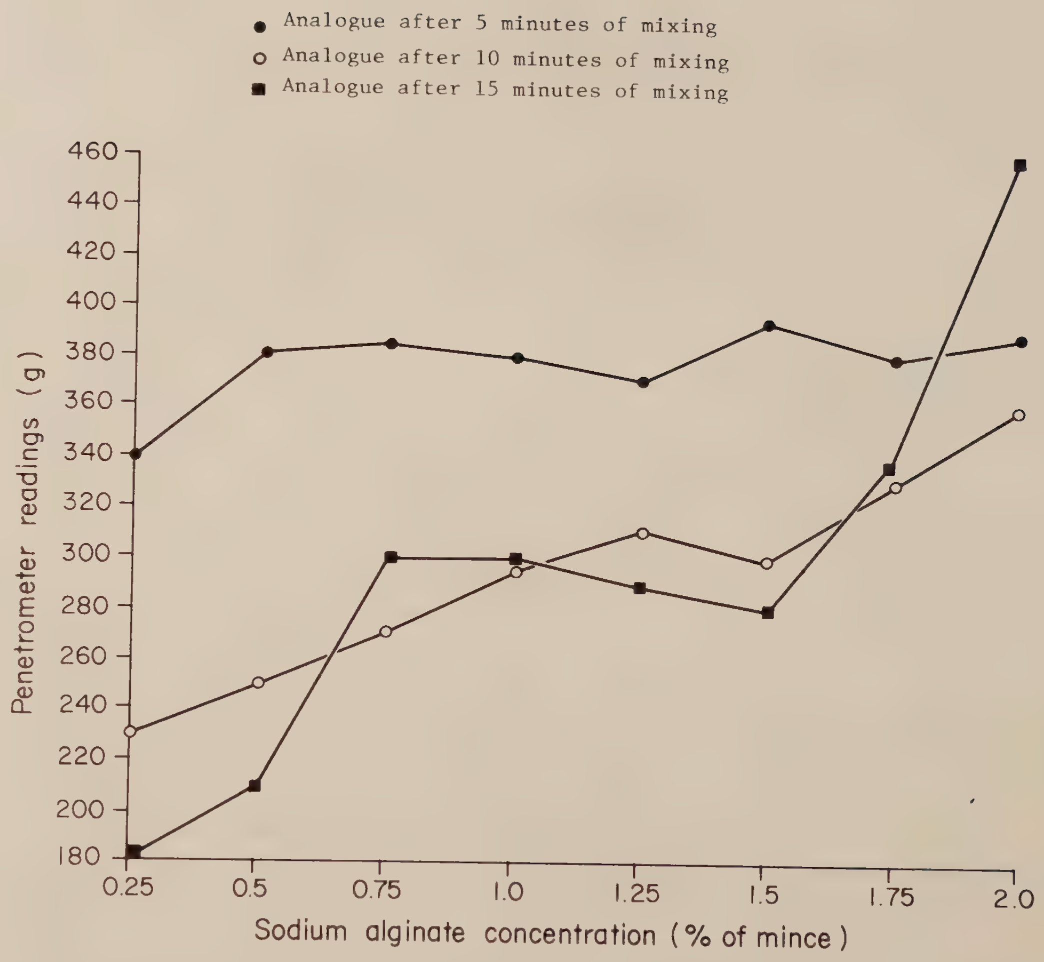

Figure 3 Resistance to applied force (measured as penetrometer reading (g)) in relation to sodium alginate binder concentration and mixing time at 20% salt level

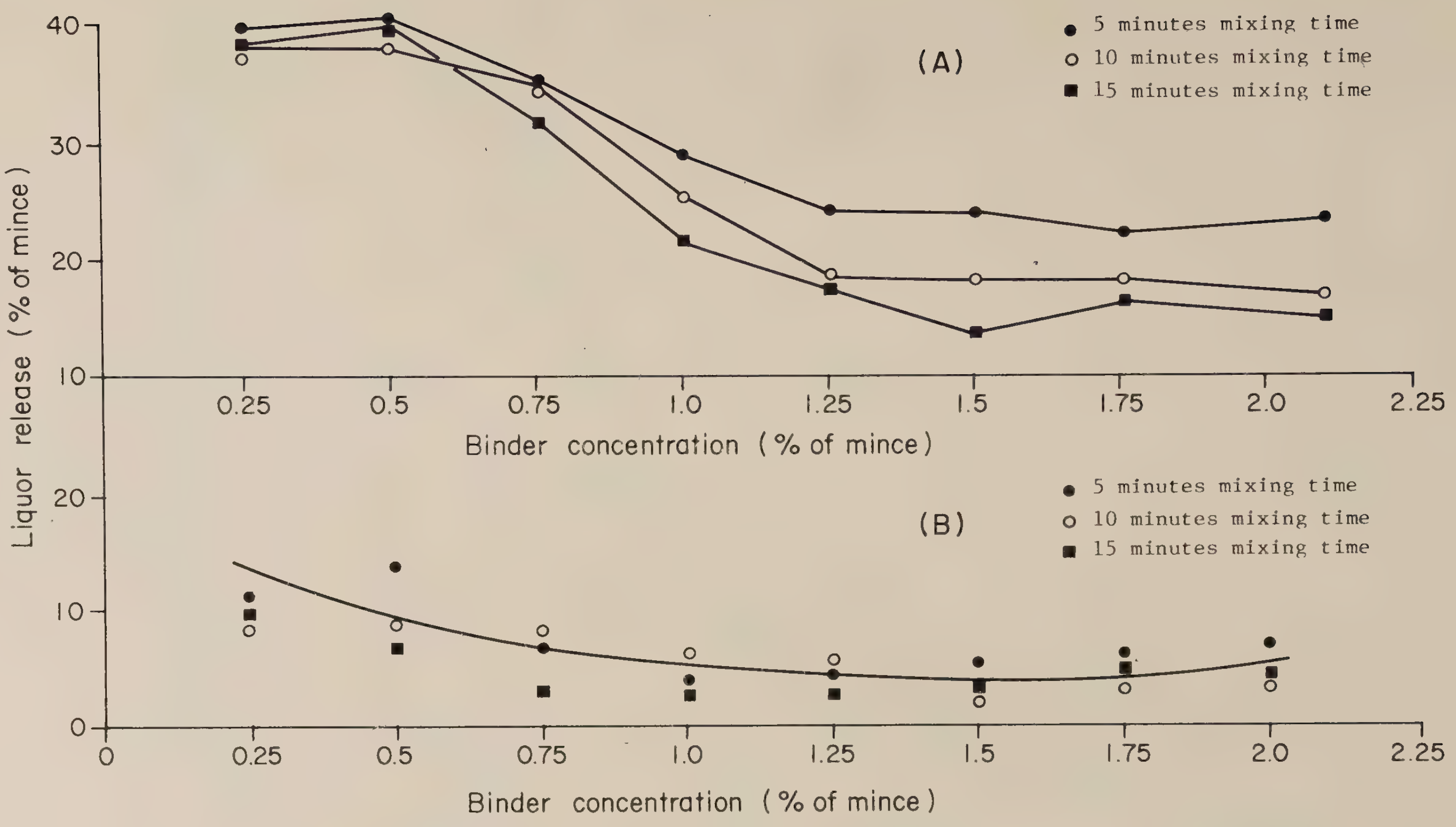

Figure 4 Percent of liquor released in relation to ACMC binder concentration and mixing time in A: 20% dry salted analogue; and B: unsalted analogue

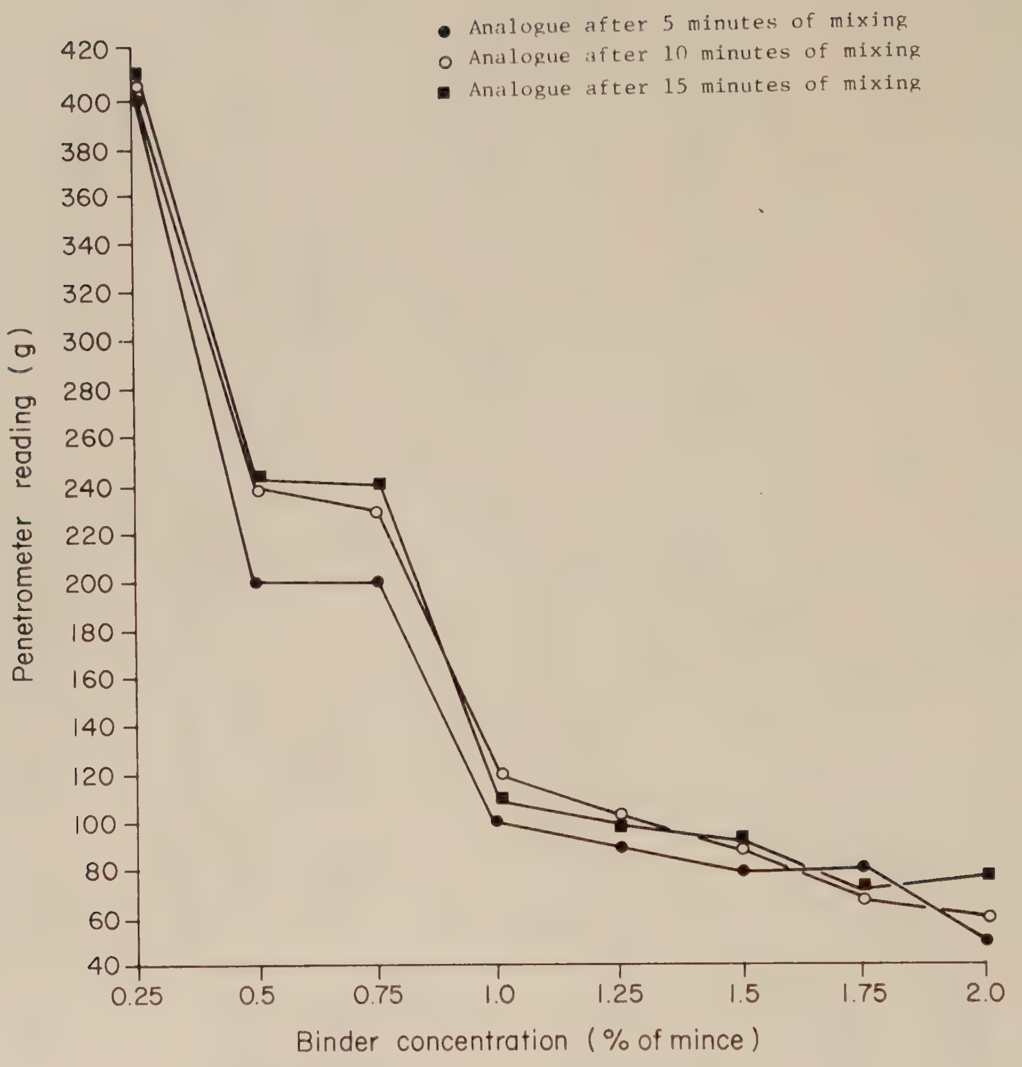

Figure 5 Resistance to applied force (as penetrometer reading (g)) in relation to ACMC binder concentration and mixing time in unsalted analogue

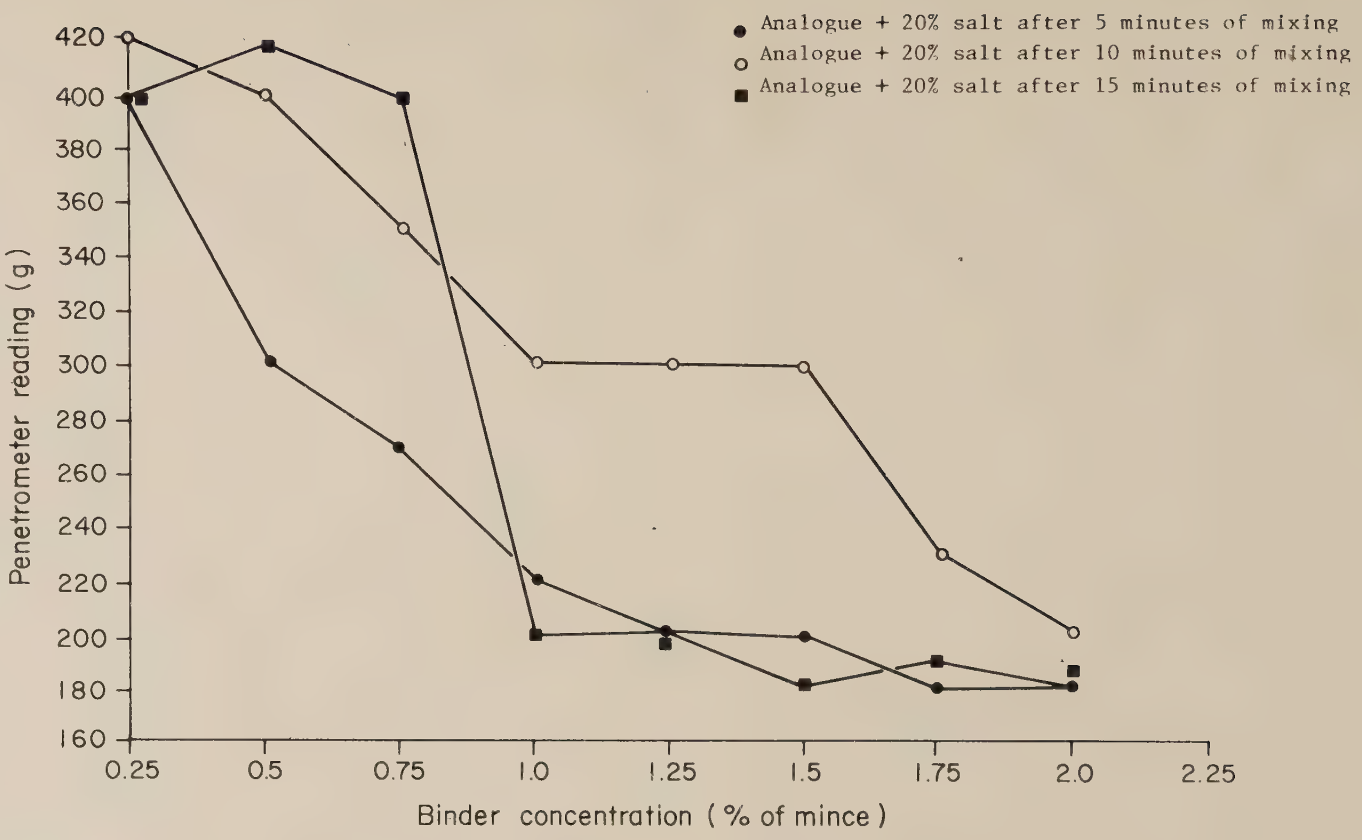

Figure 6 Resistance to applied force (as penetrometer reading (g)) in relation to ACMC binder concentration and mixing time in 20% salted analogue

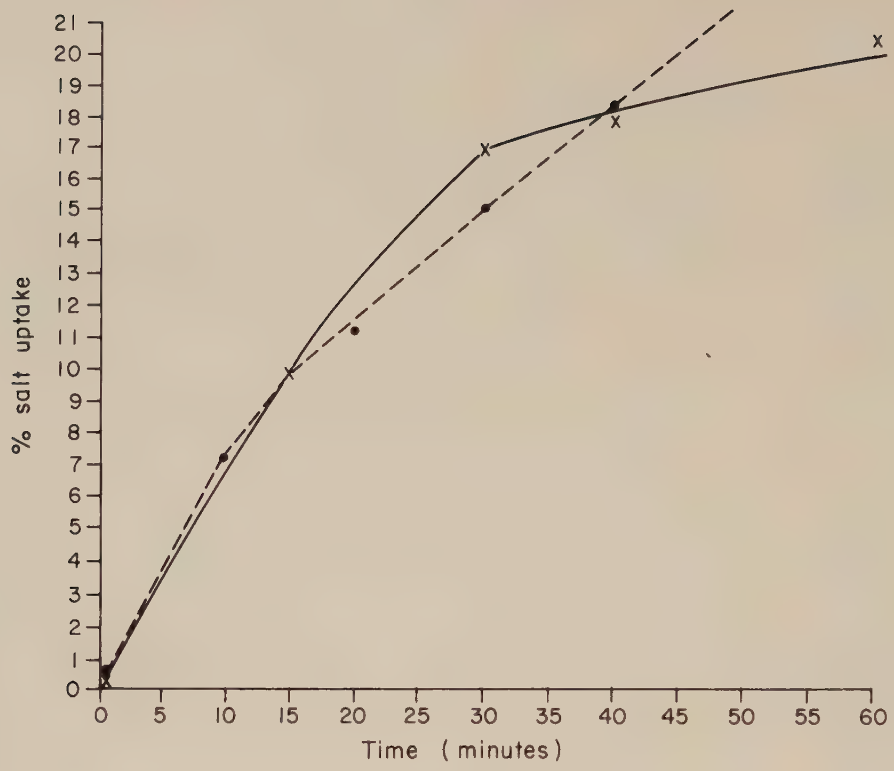

Figure 7 Salt uptake of steam cooked reformed mince boiled in saturated brine (x), and raw reformed mince boiled in saturated brine (●)

x boiled in satured brine
● boiled in the bag
o boiled in 17% brine

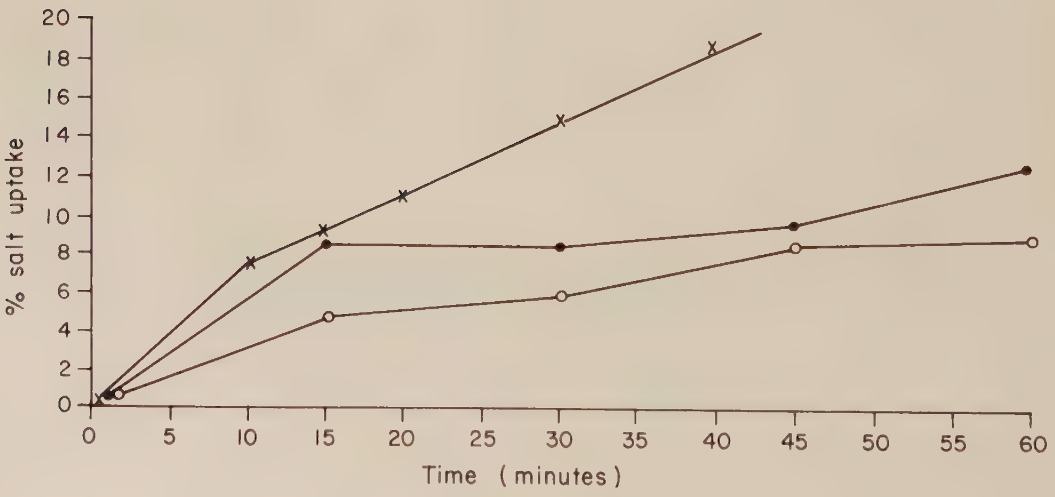

Figure 8 Salt uptake of cooked reformed mince boiled in salt (1:3) 17% brine and uncooked reformed mince boiled in saturated brine

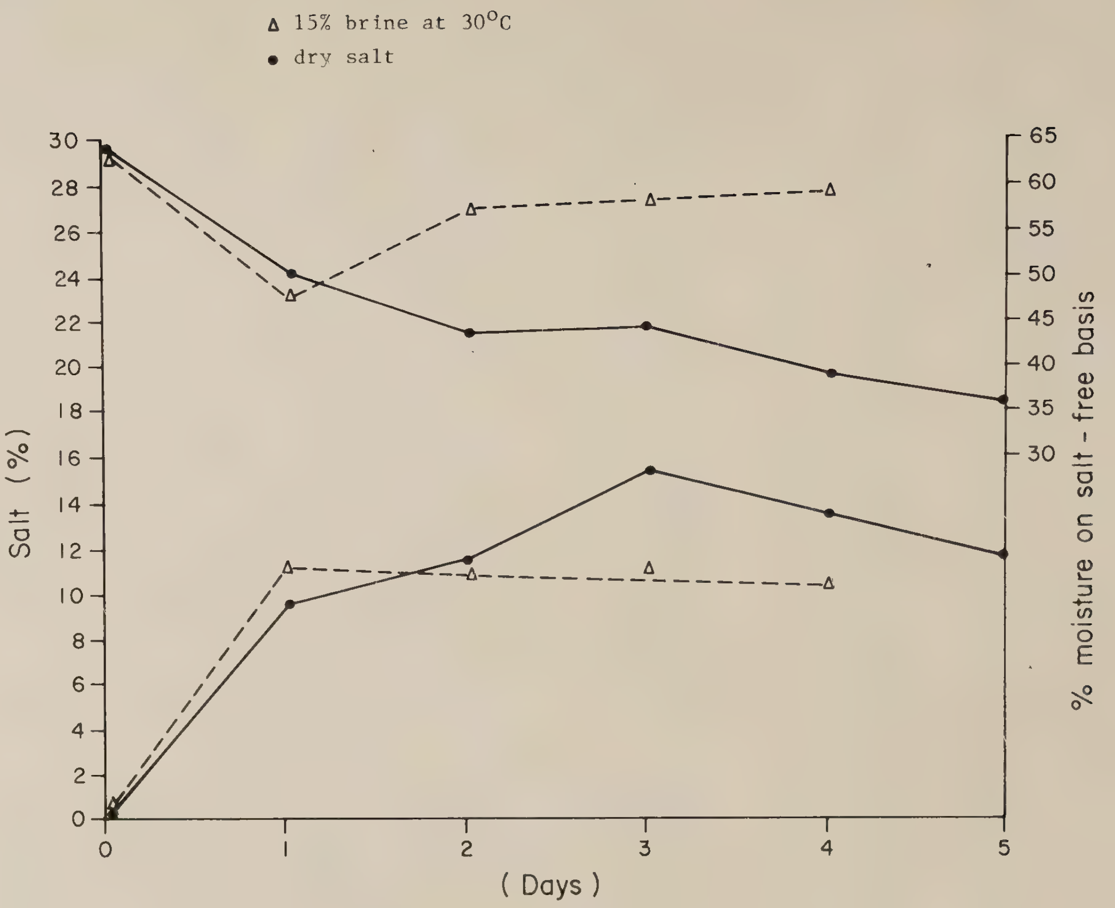

Figure 9 Percent of salt moisture levels cf cooked reformed mince dry salted and brine salted (15% brine) at 30°C (with 0.5% calcium alginate)

STORAGE CHARACTERISTICS OF FROZEN FISH MINCE PREPARED FROM UNDERUTILIZED FISH SPECIES CAUGHT IN NIGERIA WATERS - A PRELIMINARY INVESTIGATION

by

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ABSTRACT

Frozen underutilized fish species were thawed and washed with water before being mechanically separated in a Baader 694 into fish flesh and bone. The mince was packed in 500 g polythylene bags, sealed, frozen in a plate freezer and stored in a cold room at -17°C for six weeks. Samples were taken initially and weekly for sensory, microbial and chemical evaluations.

Although the quality of the frozen fish mince deteriorated with storage, the mince was still acceptable after six weeks of storage as indicated by sensory, chemical and biological parameters studied.

1. INTRODUCTION

There is a high level of wastage of small pelagic fish species that are by-catches of shrimping operations and which are often discarded or underutilized. The world's total catch is estimated at over 6 million tons (Talabi, Sorinmade and Alliu, 1982). In Nigeria, the technology of their utilization has been extended from the developed world and perfected in the area of fishmeal production. However, because of the problems of protein shortage and malnutrition in Nigeria, efforts are being made by NIOMR scientists to utilize the by-catch for human consumption by application of minced fish technology.

The scientific literature has clearly shown that protein stability is a problem in minced fish because it affects functional properties. Grantham (1981) reported that these functional properties depend on myofibrillar proteins in their native. During frozen storage, there is a conversion of trimethylamic oxide (TMAO) to dimethylamine (DMA) and formaldehyde (FA) in some species (Castell, Smith and Dyer, 1973). The formation of these compounds has been observed to be related to a loss of extractability, reduction in the waterholding capacity, gel forming ability, emulsifying capacity, rheological properties, an increase in granularity and drip loss and toughness. Also, the lipid stability of mechanically separated mince is affected by the mincing process (Ghadi and Lewis, 1977; Mai and Kinsella, 1980; Howgate, 1976; Silberstein and Lillard, 1978).

Because it is not known whether mince prepared from the by-catch of Nigerian fisheries deteriorates in the same manner, the following preliminary investigation was carried out. The storage characteristics of the mince were evaluated because the mince was considered as a raw material for fish product development and the fast food industry in Nigeria.

2. MATERIALS AND METHODS

Frozen underutilized fish species caught off Lagos area of Nigeria by "R.V. Federal Argonaut" were obtained from NIOMR's cold room, thawed and washed with tap water before being mechanically separated in a Baader 694 into fish flesh and bone.

The mince was packed in 500 g polythene bags, sealed, frozen in a plate freezer and stored in a cold room at -17°C for six weeks. Samples were taken at weekly intervals for sensory, microbial and chemical evaluations.

The mince has allowed to thaw in the refrigerator before cooking for 10 minutes in casserole dishes using a boiling water bath. Both cooked and raw mince that have been thawed were presented to a six member trained panel. While the raw mince was scored for appearance, colour and odour, cooked mince was scored for texture, juiciness, odour and flavour using a one-nine scale; one being extremely disliked, four being either liked or disliked and nine being liked extremely.

pH was determined by homogenizing 1 g of fish mince with 10 ml of distilled water and reading on a Unicam pH meter.

Trimethylamine (TMA) and total volatile bases (TVB) were determined as described by Bossey and Talabi (1981).

Lipid content has determined using Bligh and Dyer's technique (1959); hydroperoxide values were determined by the method of Lea (1978).

Free fatty acid content of the oil was measured as described by Bossey and Talabi (1981).

For microbiological determination, 10 g of mince was mixed with 90 ml of phosphate buffer and several serial dilutions were prepared before plating in standard plate agar (APHA, 1966). Each dilution was plated in duplicate and incubated at 35°C for 48 hours.

3. RESULTS AND DISCUSSION

Organoleptic characteristics of raw frozen mince are presented in Table 1. It was observed that the scores for appearance, odour and colour of mince decreased slightly with storage. The slightly low initial scores suggest that the panelists were not familiar with scoring fresh fish mince and more training will be required in future work.

Changes in acceptability of the cooked mince are shown in Table 2 (run on). The mince was still acceptable after six weeks of storage.

The effects of frozen storage on the chemical characteristics of raw frozen mince are shown in Table 3. While the lipid content was not affected by frozen storage, the peroxide value increased with storage. Oxidation of fat in mince can be determined by thiobarbituric acid (TBA), peroxide value (PV), carbonyl analysis and by sensory methods (Grantham, 1981). Large increases in TBA and PV values have been reported in mince from demersal pelagic and freshwater species during frozen storage. However, such increases have not always correlated with the sensory perception of oxidative rancidity (Tsukuda, 1978). Slight decreases in all sensory parameters were observed.

Lipid hydrolysis (lipolysis) can also be determined by free fatty acid content (FFA) and phospholipid degradation. FFA increased slightly only after five weeks of storage. Some workers have suggested that while some degree of lipid hydrolysis is evident in frozen mince, it is limited by the low activity of lipases at low temperatures and substrate competition with oxidative reactions (Tsukuda, 1978; Takama, 1974; Mai and Kinsella, 1979).

Lipolytic reactions are more significant for chilled and fresh mince. Htdrolysis of triglycerides and phospholipids can lead to large increase in FFA (Mai and Kinsella, 1980). Howgate (1976) observed that these increases contribute to off-odours and flavours in the mince, and Kinsella (1978) reported that they could damage the texture of mince by complexing with muscle proteins. It is apparent from our study that even though acceptability was reduced by lipid-derived off-odours and flavours, such conclusions cannot be made, as FFA and sensory values did not change drastically with storage time.

While pH and TVB did not change in a consistent way, the TMA content increased with storage time up till the fourth week when it started decreasing. TMAO can be broken down to TMA and subsequently to DMA and FA (Dingle, Hines and Robson, 1974). The enzymatic degradation of TMAO resulting in DMA and FA formation is a major change during frozen storage of some gadoid fish (Castell, Smith and Neal, 1971 and Tokungua, 1974). The sensitivity of these species to frozen storage is in large part due to complexing of the FA with protein resulting in loss of protein solubility and in textural toughening (Castell, Smith and Dyer, 1973; Tokungua, 1974; and Dyer, 1973). Dyer (1968) also reported that these enzymatic deterioration reactions result in loss in quality of frozen fish. Such changes are particularly rapid at temperature in the -5° to -10°C range, with decreasing activity at lower temperature (Castell, Neal and Smith, 1970; Dyer, 1973). The decrease in TMA content after four weeks may be associated with its being broken down into DMA and FA but these were not determined in this study. The breakdown of TMA to DMA and subsequently to ammonia could not be accounted for by the low TVB values. Thus, it can be concluded that TMA has been broken down to DMA and FA.

The effect of frozen storage on the microbiological count of mince is presented in Table 4. It was observed that the total viable count (TVC) decreased with storage. From a high initial count of 1.9×10^5. This was probably because the fish used has been previously stored for about five-six weeks prior to mincing. Cann and Taylor (1976) reported that the major determinant of microbiological quality of mince is the quality of the raw material. Although the fish were washed with tap water prior to use this probably did not reduce the microbial count. Nickerson II et al. sited by Grantham (1981) reported that under good hygienic conditions, pre-processing treatment of the raw material by scalding, heading and mincing has very little effect on the final quality of the mince. Furthermore, Liston (1980) observed that mince prepared under even the most controlled conditions are extremely susceptible to post-mincing contamination. Thus, minces with high levels of initial contamination have an extreme risk of spoilage on handling, storage and further processing (Grantham, 1981). This was not the case in our study as the increase in microbial count was from 1.9×10^5 to 5.5×10^5 in six weeks.

Table 1

Organoleptic characteristics of raw frozen mince

Storage period (weeks)	Characteristics		
	Appearance	Colour	Odour
0	6.0 ± 0.60	5.9 ± 0.67	5.0 ± 0.94
1	5.2 ± 0.40	5.0 ± 0.20	5.2 ± 0.89
2	5.4 ± 0.61	5.0 ± 0.96	4.4 ± 0.79
3	5.5 ± 0.54	5.1 ± 0.79	4.9 ± 0.83
4	5.1 ± 0.32	5.2 ± 0.58	4.9 ± 0.58
5	5.0 ± 0.41	4.8 ± 0.24	5.5 ± 0.41
6	5.0 ± 1.20	5.0 ± 0.95	5.0 ± 1.20

Table 2

Organoleptic characteristics of cooked mince prepared from frozen mince

Storage period (weeks)	Characteristics			
	Texture	Juiciness	Odour	Flavour
0	5.7 ± 0.98	6.0 ± 0.99	5.9 ± 0.69	5.6 ± 1.05
1	5.2 ± 0.40	5.8 ± 0.84	5.5 ± 0.77	5.5 ± 0.94
2	4.8 ± 0.60	5.3 ± 0.24	5.5 ± 0.83	5.4 ± 0.96
3	5.4 ± 0.35	5.6 ± 0.41	5.6 ± 0.50	5.8 ± 0.92
4	5.3 ± 0.24	5.3 ± 0.24	5.8 ± 0.37	5.7 ± 0.68
5	5.0 ± 0.41	5.2 ± 0.24	5.5 ± 0.41	5.4 ± 0.24
6	5.3 ± 1.30	5.9 ± 0.90	5.4 ± 1.20	5.3 ± 1.00

Table 3

Effects of frozen storage on chemical characteristics of raw frozen mince

Characteristics	Storage period (weeks)						
	0	1	2	3	4	5	6
Lipid (%)	1.0	1.2	1.2	1.1	1.1	1.0	1.0
PV (μM hydroperoxide/g)	0	1.9	2.3	5.3	8.0	4.1	11.0
FFA (%)	0.0	0.20	0.15	0.20	0.20	0.30	0.60
TMA (mg N/100 g Tissue)	1.3	1.9	2.6	2.3	4.1	3.8	2.2
TVB (mg N/100 g Tissue)	2.1	2.2	0.9	1.4	1.3	2.4	2.4
pH	7.0	7.0	6.8	7.0	7.0	7.0	6.8

Table 4

Effects of frozen storage on microbiological characteristics of raw frozen mince

Storage period (weeks)	Total viable count
0	1.9×10^5
2	2.4×10^5
4	3.6×10^5
6	5.5×10^5

In conclusion, as indicated by both sensory, chemical and microbiological quality scores, fish mince produced under the conditions in our laboratory were still acceptable after six weeks of frozen storage.

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EFFECTS OF LOW LEVELS OF SALT, MANUAL PRESSING AND STORAGE TEMPERATURE ON MICROBIAL GROWTH IN MINCE FROM UNDERUTILIZED FISH SPECIES IN NIGERIA

by

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ABSTRACT

Frozen small underutilized fish species obtained from coastal waters were thawed, gutted and washed before being mechanically deboned using a Baader 694 separator. The fish mince was divided into three batches and mixed thoroughly with 0, 2.5 and 3.5% (wt/wt) salt and packed in polythene bags before cooking in a boiling water bath for 10 minutes. Each batch was divided into two groups - not pressed and pressed with a 15 kg cylinder so as to release some moisture. Mince of different salt levels in each group was then stored at ambient temperature, chilling or freezing temperature. Samples were obtained for microbial evaluation at different periods during storage. Pressing slightly reduced the growth of microorganisms. While high concentration of salt reduced the growth of microorganisms, low storage temperature inhibits their growth considerably.

1. INTRODUCTION

Fish constitute a major source of protein in the world today particularly in the third world. For this reason, several methods of preservation are continually being examined critically, so as to enable maximum use of this commodity. The use of salt dates from antiquity and it is among the most common and cheapest methods of preservation in the tropics particularly in Nigeria.

Salt has some remarkable effects on microbial growth. Low concentrations of salt stimulate microbial growth while higher concentrations inhibit their growth. The concentration ranges over which these inhibitory effects are exerted differ for different microorganisms (Ingram, 1957). It is also known that extreme halophilic bacteria require high concentration of salt for growth. Thus, it could be said that salt has a selective action on microorganisms whereby the strongly intolerant ones such as coliform bacteria are excluded while tolerant organisms such as bacteriodes halosmophilus, red halophiles and colourless halophiles will survive in a salt medium (Ingram and Kitchell, 1967).

According to Scott (1957), the effect of salt on food is substitutive, that is, it depends on osmotic withdrawal of water which reflects the water activity in the food and which in turn will depend on the molecular ratio of the amount of dissolved solutes and of water present in the food. This ratio is often expressed as "brine concentration" (Ingram and Kitchell, 1967). The presence of other high molecular weight soluble constituents (e.g., proteins) is also microbiologically significant (Scott, 1957). A "non substitutive" behaviour is also evident among organisms requiring high concentration of sodium chloride which cannot be substituted by other salts (Ingram, 1957).

The action of salt can be viewed differently under different conditions such as influence of temperature and pressure. It has been observed that the maximum salt concentration in which growth occurs is greater at lower temperatures than at higher temperatures. The lethal action of salt is less at low temperature as salmonella are rapidly destroyed in curing brines at normal temperatures but survive for weeks at low temperature, kept industrially at 5°C. E. coli had been reported to behave similarly. The same survival pattern has been demonstrated for salmonella in culture media (Ingram and Kitchell, 1967).

However, there is a need to employ salt as a preservative technique so as to utilize the underutilized fish species which are by catches of shrimping and which are generally dumped at sea, and thereby increase protein supply in Nigeria. Among the earlier efforts to utilize these fish species in Nigeria are the notable work by Talabi (1981), Talabi (1982) and Talabi, Sorinmade and Alliu (1982). These workers employed high salt concentrations which led to a need to examine low levels of salt so as to reduce possible health hazards in people with heart related problems. Thus, the objective of this study was to determine the effects of low salt levels, manual pressing and different storage temperature on the microbial growth of fish mince produced from the underutilized fish species caught in Nigerian waters.

2. MATERIALS AND METHODS

Frozen small sized fish species caught off Lagos coastal waters by "R.V. FEDERAL ARGONAUT" were obtained from NIOMR's cold room. The fish were gutted and washed before being mechanically deboned using a Baader 694 separator. The fish mince was divided into three batches and mixed thoroughly with 0, 2.5 and 3.5% (wt/wt) salt, packed in polythene bags and sealed before cooking in a boiling water bath for 10 minutes. Each batch was divided into two groups - not pressed and pressed with a 15 kg cylinder for one minute so as to release some moisture from the mince. Mince of different salt levels in each group was then stored at ambient temperature (25°C), chill (5°C) and freezing (-17°C) temperatures. Samples were obtained for microbial evaluation at different periods during storage for a total of 28 days.

For the total viable count (TVC), standard plate count agar was used (APHA, 1966). Staphylococcal count was obtained using Mannitol salt agar (APHA, 1972). Ten grams of each sample were mixed with 90 ml of phosphate buffer and several dilutions were made. Each dilution was plated in duplicate and incubated at 35°C for 24 and 48 hours.

3. RESULTS AND DISCUSSIONS

The effects of salting, pressing and storage temperature on total viable counts (TVC) are presented in Tables 1-3. TVC increased within the first 14 days of storage in all cases. Lower counts were observed in fish mince that was stored either at refrigerated or freezing temperature when compared with mince stored at ambient temperature. It should be noted that the high initial counts in all cases might be due to the fact that fish used in this study were obtained after five-six weeks of frozen storage. While salting suppressed the growth of microorganisms, the addition of salt was less effective at room temperature as all the products putrefied strongly within two weeks and sampling was discontinued after this period. At 2.5% and 3.5% salt treatments and a lot of salt intolerant organisms (Coliform, pseudomonas and staphylococci) some of which are putrefying would have been eliminated and substituted with some of the salt tolerant organisms that are non-putrefying.

The lethal action of salt has already been proven to be less at low temperature (Ingram and Kitchell, 1967). It is also known that at lower temperatures, the thermophilic and mesophilic organisms are replaced by the psychrophiles (Brown and Melling, 1971). Ingram and Kitchell (1967) reported that the preservation action of salt on fish increased with reduction of temperature from 21°C to 10°C which infers a reduced salt tolerance at lower temperature. Salt concentrations which are ineffective at high temperatures may become inhibitory or at least result in markedly delayed outgrowth as the temperature falls to 10°C or below (Ingram and Kitchell, 1967). It is also known that the optimum and maximum temperatures for growth are raised when an organism grows in the presence of salt and the rise is large when an organism tolerates high salt concentrations (Ingram, 1957). This is probably the reason for the reduction in total viable count of the salt treated mince both at refrigerated and freezing temperatures as observed in this present study.

Vibrio organisms are known to occur naturally on fish. V. parahaemolyticus is even halophilic and is pathogenic to man if ingested in great number. In this study, both the salted and unsalted mince stored at room temperature had high counts of vibrio (Table 4). For the mince stored at refrigerated (Table 5) and freezing (Table 6) temperatures, the counts were relatively lower with storage both in the salted and unsalted samples. This pattern of result is understandable because of the halophilic nature of some species of vibrio and their sensitivity to cold particularly 0°-5°C. In actuality, heat above 48°C and cold below 5°C and denial of salt are sufficient to limit the growth of vibrio. In addition pressing seems to slightly reduce the growth of vibrio in most cases.

Coliform organisms are "indicator" organisms, that is, indicative of the possibility of faecal contamination. They have become a useful index in salted products. This work shows that the addition of 2.5% and 3.5% salt had the effect of reducing the number of coliform organisms when compared with the unsalted product (Tables 7, 8 and 9). At room temperature, fish mince without added salt had coliform counts of up to 10^8 by the fourteenth day (Table 7). The mince with 2.5% and 3.5% added salt had lesser counts. At refrigerated storage temperature the count for the salted mince was as low as 10^5 by the fourteenth day (Table 8) while at freezing temperature the coliform count at 3.5% added salt was 10^4 (Table 9). The effect of temperature on the preservative action of salt has been clearly illustrated here. It has been showed that the growth of coliform organisms is prevented by concentration of sodium chloride exceeding about 6%. The preservative action of salt and temperature on a product with reference to coliforms will depend on different reactions of the different members of the coliform group, e.g., salmonella survives better than E. coli. At 5°C in 12% salt, no E. coli survived 15 days whereas 10-40% salmonella remained viable under the same conditions (Ingram and Kitchell, 1967). Also, it is apparent that pressing only reduced the growth of coliform slightly in this product.

Tables 10-12 present the effects of salting, pressing and storage temperatures on staphylococcal counts of mince. Staphylococcus aureus is a food poisoning, mesophilic organism. At refrigerated temperature, much of the staphylococci were eliminated in this study. This resulted in lower counts in mince stored at refrigerated temperature when compared with ambient storage temperature

(Tables 10 and 11). At freezing temperature, the stronger preservative action of salt was observed (Table 12) as there were lower counts for salted mince than for the unsalted mince. Furthermore, pressing seems to slightly reduce growth of staphylococci in both the salted and unsalted mince without regards to storage temperature.

In conclusion, it is evident that rapid bacterial growth followed by deterioration or spoilage could be controlled by salting and storage of mince products at low temperatures and the added effect of pressing cannot be over-emphasized as a certain amount of moisture is pressed out during the process. Under these conditions fish mince can be held for several weeks without objectionable odour or appearance and with reduced bacterial growth before utilization in fish products.

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Table 1

Effects of low levels of salt, pressing and ambient storage time on total viable count of fish mince[a]

Storage period (days)	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	2.01×10^6	6.4×10^5	6.50×10^5	5.6×10^5	6.1×10^5	5.0×10^5
2	2.5×10^7	3.3×10^7	4.8×10^6	4.0×10^6	6.0×10^6	5.1×10^6
7	3.6×10^8	2.6×10^8	1.88×10^7	1.6×10^7	4.0×10^7	2.4×10^7
14	3.8×10^8	2.8×10^8	2.42×10^8	1.92×10^8	2.02×10^8	1.7×10^8

a/ After two weeks, product smell was unbearable

Table 2

Effects of low levels of salt, pressing and refrigerated storage time on total viable count of fish mince

Days	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	2.01×10^6	6.4×10^5	6.5×10^5	5.6×10^5	6.1×10^5	5.0×10^5
2	3.2×10^7	2.4×10^7	2.6×10^6	2.34×10^6	2.4×10^6	2.2×10^6
7	2.6×10^6	2.0×10^6	1.7×10^6	1.4×10^6	1.4×10^6	1.3×10^5
14	2.4×10^6	1.7×10^6	1.46×10^6	1.24×10^6	1.18×10^5	1.02×10^5
21	2.1×10^6	1.4×10^6	1.0×10^5	9.6×10^5	8.0×10^5	7.0×10^5
28	1.9×10^6	1.3×10^6	7.8×10^5	7.0×10^5	6.2×10^5	4.0×10^5

Table 3

Effects of low levels of salt, pressing and frozen storage time on total viable count of fish mince

Days	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	2.01×10^6	6.4×10^5	6.5×10^5	5.6×10^5	6.1×10^5	5.0×10^5
2	1.9×10^6	1.8×10^6	8.0×10^5	6.6×10^5	7.0×10^5	6.2×10^5
7	2.9×10^5	2.00×10^5	1.6×10^5	1.5×10^5	1.4×10^5	1.26×10^5
14	1.48×10^6	1.3×10^6	1.5×10^5	1.4×10^5	1.34×10^5	1.0×10^5
21	2.0×10^5	1.58×10^6	1.4×10^5	1.3×10^5	1.16×10^5	9.2×10^4
28	1.0×10^5	8.4×10^5	1.18×10^5	1.08×10^5	7.6×10^5	6.0×10^5

Table 4

Effects of low levels of salt, pressing and ambient storage time on vibrio count of fish mince[a/]

Storage period (days)	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	4.9×10^5	4.4×10^5	4.4×10^5	4.2×10^5	4.0×10^5	3.9×10^5
2	2.2×10^6	1.4×10^6	4.0×10^6	2.4×10^6	1.92×10^6	1.3×10^6
7	1.7×10^7	1.3×10^7	1.82×10^7	1.5×10^7	8.0×10^7	7.0×10^7
14	2.84×10^7	1.7×10^7	1.9×10^8	1.4×10^8	2.04×10^8	1.78×10^8

[a/] After two weeks, product smell was unbearable.

Table 5

Effects of low levels of salt, pressing and refrigerated storage time on vibrio count of fish mince

Storage period (days)	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	4.9×10^5	4.4×10^5	4.4×10^5	4.2×10^5	4.0×10^5	3.9×10^5
2	1.2×10^7	5.4×10^6	2.0×10^6	1.9×10^6	1.22×10^6	1.96×10^6
7	1.2×10^6	9.0×10^5	1.7×10^6	1.2×10^6	1.50×10^7	4.0×10^6
14	1.06×10^6	7.8×10^6	1.28×10^6	1.14×10^6	1.4×10^6	1.3×10^6
21	8.0×10^5	4.2×10^5	1.14×10^5	8.6×10^5	1.2×10^6	1.16×10^5
28	6.4×10^5	3.2×10^5	1.02×10^5	7.8×10^5	1.08×10^6	1.04×10^6

Table 6

Effects of low levels of salt, pressing and frozen storage time on vibrio count of fish mince

Storage period (days)	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	4.9×10^5	4.4×10^5	4.4×10^5	4.2×10^5	4.0×10^5	3.9×10^5
2	1.0×10^6	4.8×10^5	1.7×10^5	1.2×10^5	1.8×10^5	1.5×10^5
7	7.0×10^5	4.2×10^5	9.0×10^5	3.6×10^5	1.4×10^5	1.18×10^5
14	6.0×10^5	5.4×10^5	9.0×10^5	7.6×10^5	1.16×10^6	9.4×10^5
21	5.2×10^5	3.0×10^5	7.8×10^5	3.8×10^5	1.0×10^5	8.2×10^5
28	3.2×10^5	2.0×10^5	6.0×10^5	4.6×10^5	8.2×10^5	6.4×10^5

Table 7

Effects of low levels of salt, pressing and ambient storage time on coliform count of fish mince[a]

Storage period (days)	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	1.86×10^{5}	1.80×10^{5}	1.2×10^{5}	1.0×10^{5}	1.1×10^{5}	1.0×10^{5}
2	1.9×10^{7}	1.7×10^{7}	1.78×10^{6}	2.4×10^{6}	5.1×10^{6}	4.0×10^{6}
7	2.28×10^{8}	1.6×10^{8}	1.86×10^{7}	1.56×10^{7}	1.14×10^{7}	1.02×10^{7}
14	2.0×10^{8}	1.82×10^{8}	4.8×10^{7}	3.0×10^{7}	4.2×10^{7}	2.6×10^{7}

[a] After two weeks, product smell was unbearable

Table 8

Effects of low levels of salt, pressing and refrigerated storage time on coliform count of fish mince

Storage period (days)	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	1.86×10^{5}	1.80×10^{5}	1.2×10^{5}	1.0×10^{5}	1.1×10^{5}	1.0×10^{5}
2	3.6×10^{6}	3.0×10^{6}	2.0×10^{6}	7.4×10^{6}	1.0×10^{5}	7.2×10^{5}
7	1.9×10^{6}	1.4×10^{6}	3.40×10^{5}	3.20×10^{5}	3.2×10^{5}	2.0×10^{5}
14	1.2×10^{6}	8.6×10^{5}	2.4×10^{5}	2.0×10^{5}	1.8×10^{5}	1.6×10^{5}
21	7.6×10^{5}	5.2×10^{5}	2.0×10^{5}	1.4×10^{5}	1.6×10^{5}	1.0×10^{5}
28	4.0×10^{5}	3.6×10^{5}	1.4×10^{4}	8.0×10^{4}	8.0×10^{4}	6.0×10^{4}

Table 9

Effects of low levels of salt, pressing and frozen storage time on coliform count of fish mince

Storage period (days)	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	1.86×10^{5}	1.80×10^{5}	1.2×10^{5}	1.0×10^{5}	1.1×10^{5}	1.0×10^{5}
2	1.6×10^{6}	1.0×10^{6}	1.0×10^{6}	9.0×10^{5}	7.0×10^{5}	6.0×10^{5}
7	1.1×10^{5}	8.0×10^{5}	2.6×10^{5}	2.2×10^{5}	2.0×10^{5}	1.8×10^{5}
14	7.4×10^{5}	6.2×10^{5}	1.8×10^{5}	1.2×10^{5}	1.0×10^{4}	8.0×10^{4}
21	5.8×10^{5}	4.8×10^{5}	1.2×10^{5}	1.0×10^{5}	8.0×10^{4}	4.0×10^{4}
28	3.4×10^{5}	2.0×10^{5}	1.0×10^{5}	6.0×10^{4}	6.0×10^{4}	2.0×10^{4}

Table 10

Effects of low levels of salt, pressing and ambient storage time on staphylococcal count of fish mince[a]

Storage period (days)	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	3.8×10^5	3.0×10^5	3.0×10^5	2.2×10^5	2.7×10^5	2.0×10^5
2	1.28×10^7	5.0×10^6	7.0×10^6	3.6×10^6	1.6×10^6	4.1×10^6
7	1.8×10^7	8.0×10^6	1.0×10^7	7.0×10^6	8.8×10^6	6.0×10^6
14	2.10×10^7	1.3×10^7	1.5×10^7	1.18×10^7	1.20×10^7	9.0×10^6

a/ After two weeks, product smell was unbearable

Table 11

Effects of low levels of salt, pressing and refrigerated storage time on staphylococcal count of fish mince

Storage period (days)	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	3.8×10^5	3.0×10^5	3.0×10^5	2.2×10^5	2.7×10^5	2.0×10^5
2	5.4×10^6	5.0×10^6	5.0×10^6	4.4×10^6	4.6×10^5	3.6×10^6
7	5.0×10^5	4.6×10^5	4.4×10^5	4.0×10^5	4.0×10^5	3.6×10^6
14	4.6×10^5	4.0×10^5	3.8×10^5	3.4×10^5	3.6×10^5	3.0×10^5
21	4.0×10^5	3.8×10^5	3.6×10^5	3.2×10^5	2.8×10^5	2.6×10^5
28	3.8×10^5	3.2×10^5	3.0×10^5	2.8×10^5	2.6×10^5	2.2×10^5

Table 12

Effects of low levels of salt, pressing and frozen storage time on staphylococcal count of fish mince

Storage period (days)	0%		2.5%		3.5%	
	Unpressed	Pressed	Unpressed	Pressed	Unpressed	Pressed
0	3.8×10^5	3.0×10^5	3.0×10^5	2.2×10^5	2.7×10^5	2.0×10^5
2	4.8×10^6	4.6×10^6	4.4×10^5	4.0×10^5	3.8×10^5	3.6×10^5
7	4.2×10^5	4.0×10^5	3.6×10^5	3.2×10^5	3.2×10^5	2.8×10^5
14	3.8×10^5	3.2×10^5	3.0×10^5	2.8×10^5	2.4×10^5	2.0×10^5
21	2.8×10^5	2.6×10^5	2.2×10^5	1.8×10^5	1.6×10^5	1.4×10^5
28	2.6×10^5	2.4×10^5	2.0×10^4	1.4×10^4	1.0×10^5	8.0×10^4

SESSION 3:

PREVENTION OF POST-HARVEST LOSSES/
PREVENTION DES PERTES APRES CAPTURE

THE PROBLEM OF CHOICE OF SAFER METHODS OF REDUCING POST-HARVEST LOSSES IN LAKE CHAD PROCESSED FISH

by

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ABSTRACT

Most Fishery Industries in Nigeria are experiencing a decline in the total tonnage of fish harvested. While our population is increasing, estimated at 166 million in year 2000, and therefore demand for fish is rising, post harvest losses in processed fish exacerbate the problems associated with high demand and insufficient supply of fish.

This paper deals with some of the technological approaches available to Lake Chad fishery industries with a view to reducing post harvest losses and providing products with a better nutritive value during our 4th National Development Plan. The paper also considers the social aspects of adopting some of the policies to combat problems of post harvest losses.

1. INTRODUCTION

Lake Chad provides a substantial animal protein resource in Nigeria, with a yield of 80-100 kg/ha. The total catch is strongly influenced by the water level which is subject to great variations due to rainfall cycles in the Chari Basin, which accounts for 85% of the annual water intake. After the extreme highwater level of the late fifties and early sixties, when the maximum surface area was recorded at 25 000 km^2, the Lake reached a minimum of 6 000 km^2 in the second half of 1974 (Figure 1) (Maembe, 1982). During 1978-84 an even worse recession in the shoreline and surface area of the lake has been recorded.

Important commercial development of the Lake Chad fisheries started in the late fifties with the introduction of cheap, ready-woven nylon nets, fish hooks, nylon string, cement sinkers, an improved system of mounting the fishing gears, and the introduction of wooden dugout, and plank and plywood canoes. The catch rose dramatically from 10 000 tons to 75 000 tons during the sixties. With the reduction of the water surface during the early seventies, the catch rose further to a level of 224 000 tons in 1974. The catch, about 80% of which was smoked, 15% being sundried, putrefied fish, and the rest sold fresh to local consumers, found a ready market in the larger cities of the north, and especially in the more populous South region which has an acute shortage of animal protein (Azeza, 1982).

The "miraculous" catches (1973-75) brought large numbers of professional fishermen from the Nigerian delta regions and other important lakes adversely affected by their ecological regimes to Lake Chad. The same period saw profound changes in the northern part of the Lake, which progressively dryed up, forcing efforts to be concentrated on the Southern basin, south of the grand barrier. The catch began to fall progressively to around 80 000 tons in 1983.

Although considerable spoilage (estimated at between 20-50 percent) through decomposition and insect infestation had already been observed in the sixties and early seventies, the scale of the problem had increased proportionately with the increase of the catch. In 1974 the calculated economic loss was very significant. Insect infestation was known to be of two types: initially, when the moisture content of the fish is high it provides a suitable breeding ground for several species of flies; when the moisture content falls, the dermestes beetles ravish the product, causing very substantial loss. Very extensive breakages diminish further the economic value of the products: the products, which are very brittle, are roughly handled during sorting, packaging and transportation on poor roads connecting Baga to Maiduguri. These effects substantially diminished the quantity of product, and also caused proportionate increases in its price, especially on the retail market to the detriment, in particular, of the poorest consumer who, in general, needs the protein most.

2. STATUS OF PROCESSED LAKE CHAD FISH

An assessment of the quality of processed Lake Chad fish was undertaken as a basis for determining the type of losses suffered before the product reaches the consumer. Past estimates (Rollings and Hayward, 1962, Osuji, 1976, Azeza, 1976) have recorded losses of processed fish due to insect infestation, poor handling, storage, packaging, transportation and damage by rodents to be 40 to 60 percent (Azeza, 1976, Osuji, 1976, Rollings and Hayward, 1962). Traditionally processed Lake Chad fish, as in most artisanal fish industries, provides an estimated 21-30% of the annual fish consumed in Nigeria. The main fish species of commercial importance were *Lates niloticus*, *Synodontis* spp.; *Mormyrops* spp.; *Bagrus bayad*; *Labeo* spp., *Citharinus citharus*; *Distochodus* spp.; etc. up to 1974; replaced during the post-drought regime by *Clarias* spp.; *Gymnarchus niloticus*: *Heterotis niloticus* and *Tilapia* spp.

All over the Lake, hot-smoking is the major method of fish preservation. During the pre-drought regime, very large fishes were chunked up before smoking, to produce "banda" or coiled fish called "tonkoso". Putrefied fishes are customarily split head to tail and hung for sun-drying to produce a product which is a local delicacy. Firewood was scarce in the pre-drought period in the industry. Smoked fish were therefore charred or scorched using burning grass and useless mats placed on top of the fish followed by sun-drying (Azeza, 1976). Scorching produced a dirty product covered with soot, dry on the outside because of case hardening but uncooked inside. Scorched "banda" therefore suffered rapid deterioration in quality (Maembe, 1982). At one time fish products have been and are stored by fishermen and processors in makeshift areas in the fish landing and processing centres. These stores are permanent, perenial or temporary, depending upon the size of landings near the village. Lots are accumulated until a marketable load is achieved (Figure 2). The marketing chain for these fish products leads to Southern Nigeria with the main market centres in Onitsha, Enugu, Jos and Lagos. Smaller quantities of smoked fish, including all the sun-dried fish, are marketed in Borno and Kano states (Figure 3).

3. PROCESSING METHODS

The method of processing fish in Lake Chad often leads to losses in economic value and protein content. To attempt to reduce these losses fishermen and processors have adopted different techniques.

3.1 Light Brining

In Lake Chad, this method was initially adopted in the early 60's when the State Ministry of Natural Resources subsidized procurement and distribution of salt to fishermen and processors. It was necessary to use the right quality or quantity of the salt in order to avoid "pink", whilst producing an acceptable, tasty product. Salt curing is used as a preservative method because salt slows down or prevents bacterial spoilage of fish depending on concentration. At the same time the taste is enhanced by the salt and by enzymatic and chemical reactions. The phenolic falvour is obtained by the deposition of smoke constituents. The main features of salting are the removal of some of the water from the fish flesh and its partial replacement with salt. Salt up-take and water loss are influenced by the fattiness of the fish, the thickness of the flesh, freshness, temperature and the chemical purity of the curing salt. "Banda" production was an important fish processing method when large fish were caught and firewood was scarce; later, when the ecological regime of the Lake had changed and firewood was available to smoke the very oily *Clarias* spp., "tonkoso" became important.

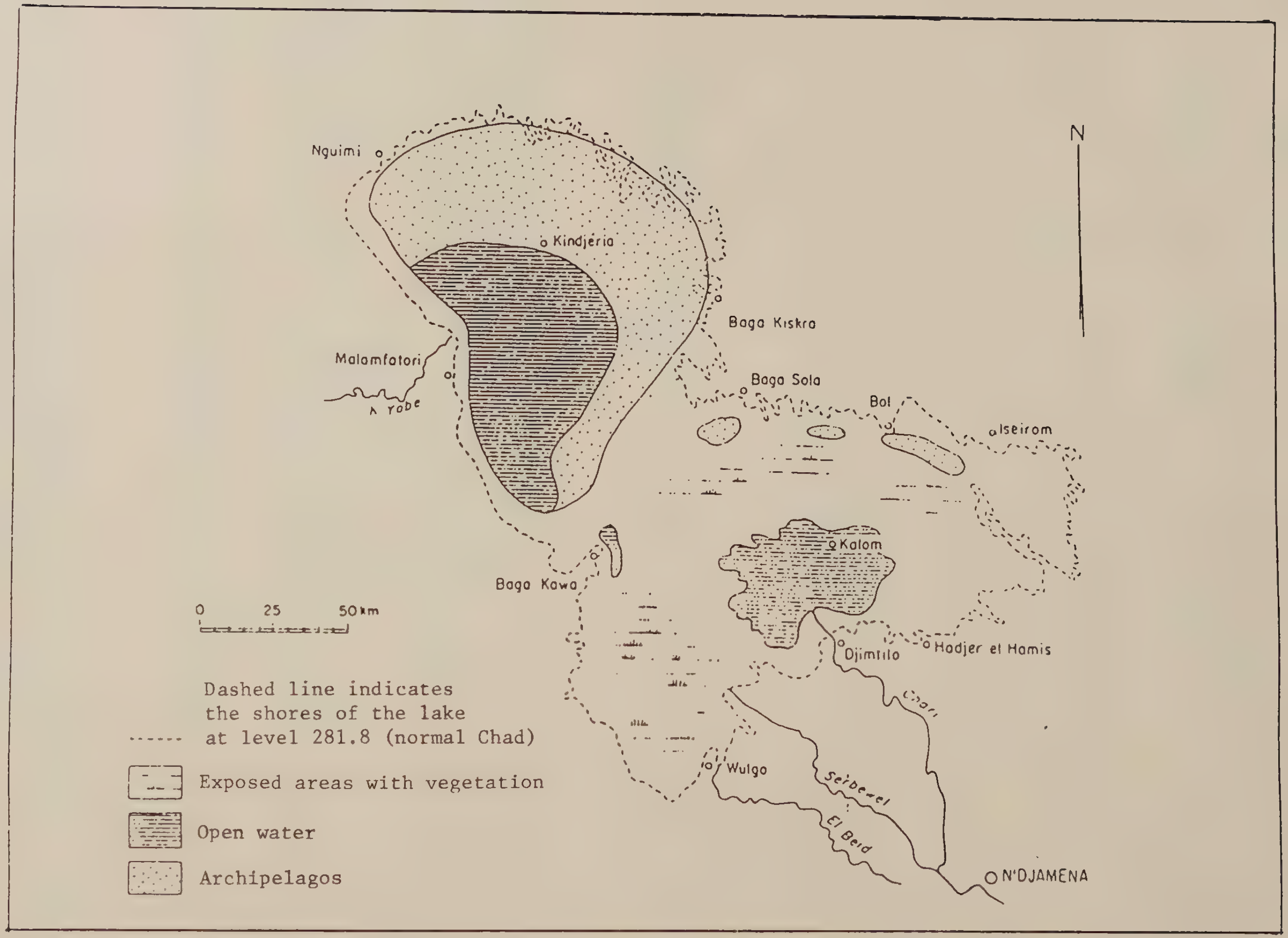
In the course of the project assisted by FAO at the Lake Chad Research Institute (NIR/74/001), various brining experiments involved fish species (*Clarias lazera*, *Tilapia* spp., *Heterotis niloticus*, *Gymnarchus niloticus*) were carried out at different times of the year.

3.2 Reheating the Already Smoked Product

This is another technique employed by fishermen and processors to reduce infestation. In the project NIR/74/001, it was concluded after several reheating trials of smoked fish, that the product could be rendered insect-free if heated to 50°C for 25 minutes. Reheating at this temperature every five days kept the product insect-free; reheating every ten days kept the losses from insect infestation to a minimal figure without appreciable loss to the protein content of the fish. The average weight loss on reheating was only 1.6%. Repeated reheating did not reduce the overall weight, as the weight losses were quickly counteracted by the product coming to equilibrium with the prevailing humidity. No adverse effects regarding colour and texture were observed in the reheated fish. Reheating has become widely accepted.

3.3 Sundrying

Although most of the fish caught was smoked, a proportion, which can be substantial during the hot season, is so spoiled that it can no longer be smoked. This fish is sundried and finds a ready market in the Northern regions of Nigeria, despite its rancidity. It has been observed that during drying this product (bunyi yauri = Kanuri) suffered serious damage by maggots. Successful campaigns


N
Nguimi
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Iseirom
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Yobe
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Hodjer el Hamis
Chari
Wulgo
Seibewel
El Beid
N'DJAMENA
0 25 50km
Dashed line indicates the shores of the lake at level 281.8 (normal Chad)
Exposed areas with vegetation
Open water
Archipelagos

Figure 1 Outline map of Lake Chad showing Lake levels (July 1937)

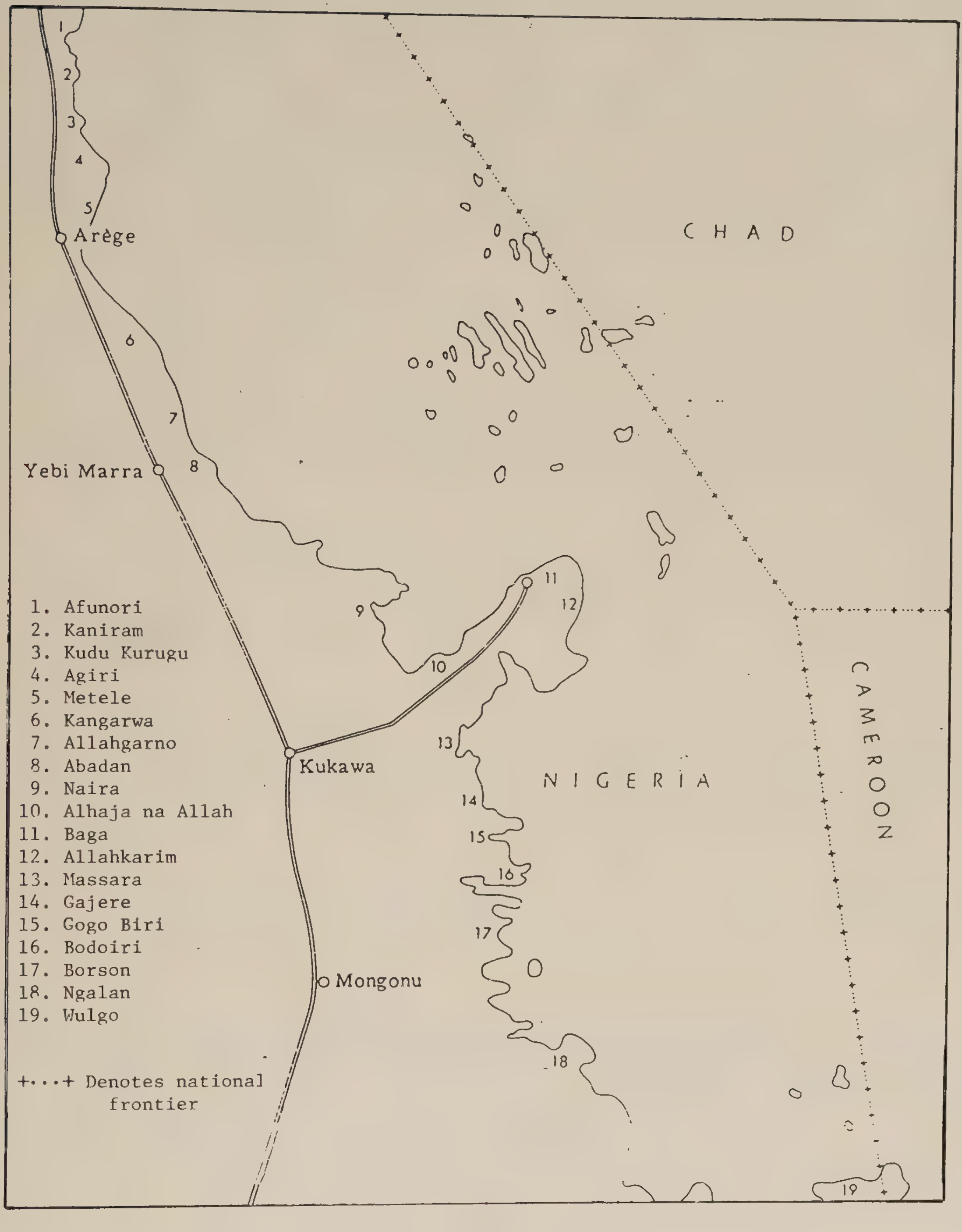
CHAD
NIGERIA
CAMEROON
Arège
Yebi Marra
Kukawa
Mongonu
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
1. Afunori
2. Kaniram
3. Kudu Kurugu
4. Agiri
5. Metele
6. Kangarwa
7. Allahgarno
8. Abadan
9. Naira
10. Alhaja na Allah
11. Baga
12. Allahkarim
13. Massara
14. Gajere
15. Gogo Biri
16. Bodoiri
17. Borson
18. Ngalan
19. Wulgo
+...+ Denotes national frontier

Figure 2 Map of shoreline villages
(southwest portion of Lake Chad, Nigeria)

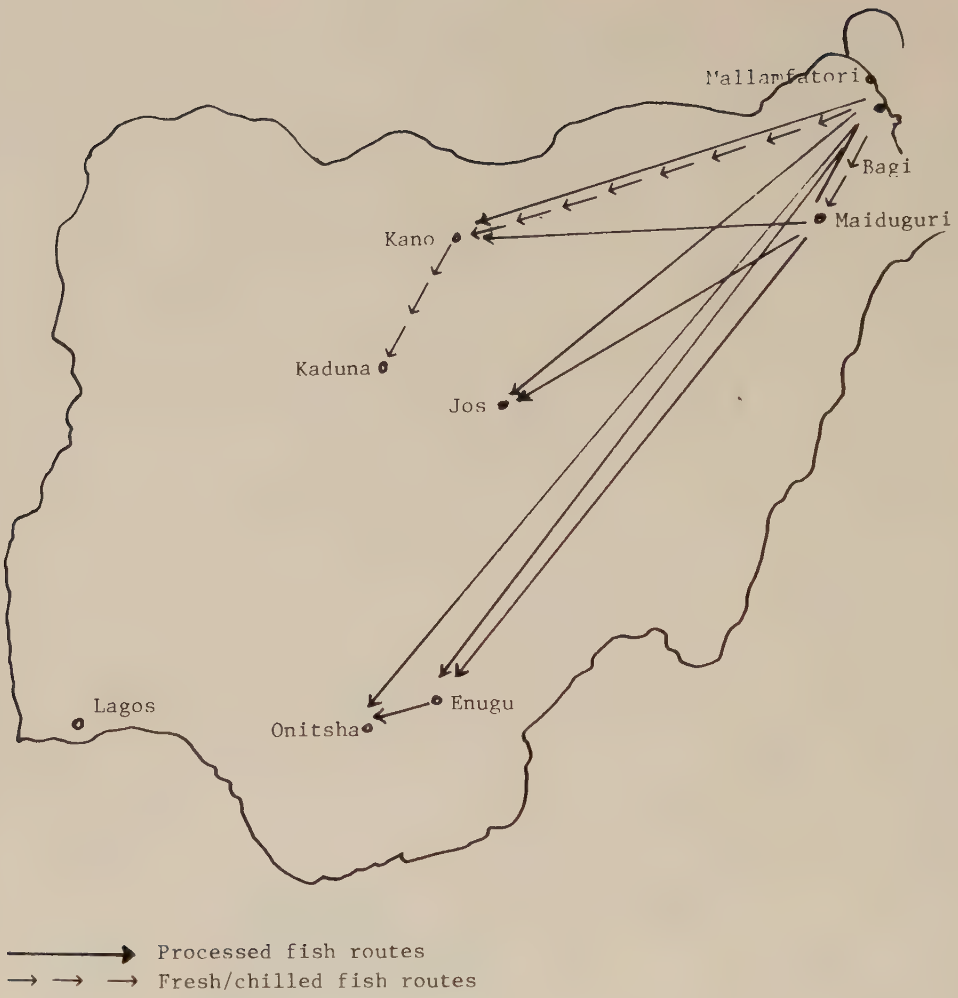
Mallamfatori
Bagi
Maiduguri
Kano
Kaduna
Jos
Lagos
Onitsha
Enugu
Processed fish routes
Fresh/chilled fish routes

Figure 3 Major distribution routes for processed and fresh/chilled Lake Chad fish

Note: Some of the fish is packed and transported directly from the Lake to the main market centres, e.g., Kano, Jos, Onitsha, Enugu

- There is also transfer of fish by some traders from one centre to another, e.g., Maiduguri - to the market centres or Enugu to Onitsha

- Lagos is not shown as a main market centre because only small quantities of fish go there by extension workers has greatly reduced the direct use of the insecticide shelltox (Dichlorvos aerosol), which had been a regular method for controlling maggot infestation. Infestation is now prevented by drying in a large mosquito wire covered cage. This reduces losses of edible material and the incidence of breakage.

4. PROTECTION OF FISH PRODUCTS AGAINST LOSSES AND ANALYSIS FOR INSECTICIDES

All the methods of fish processing discussed above have built-in techniques to reduce losses. However, due to a scarcity of firewood and high prices of salt, fishermen and processors have found that such techniques did not always prevent insect infestation. Thus attempts are made to counteract the deterioration by the indiscriminate use of insecticides which could create hazards to human health since the effectiveness of the various products used as preservatives are largely unknown. Chemicals which it is suspected are used are:

- Gamma HCH (Lindane or Gamalin 20)
- Dihlorvos aerosols (Shelltox)
- DDT
- Tetrachlorvinphos (Gardona)

In order to test for these chemicals, during October 1983, fish products (worth ₦ 200.00) were bought from Tetewa, Kangalam and Bol on Lake Chad, Baga Doros I and II, and Maiduguri fish market. They were labelled A, B, C, D, E and A', B', C', D', and E'. Samples for injection were extracted and stored in refrigerators in the Federal Department of Pest Control Services Laboratory at Kaduna.

On 20th March 1984, the beginning of the hot season in Lake Chad, fish products of the following species were bought from the same fish markets mentioned above.

- "Tonkoso" or coiled, smoked Clarias spp.
- Bagrus bayad
- Lates niloticus
- Synodontis spp.

4.1 Extraction and Sample Preparation

Extraction of the samples was based on a laboratory of the Government Chemist (London) method for pesticides in fats. Other methods of extraction and preparation were based on G. Zweig's analytical method (Zweig, 1980).

4.2 Sample Injection

The extracts from the first batch of fish products were taken to the A.B.U. Zaria - Chemistry Department for Gas Liquid Chromatographic (GLC) analyses. A batch of Lates niloticus bought on 20/3/84 was also extracted and analysed.

4.3 Results

The preservative effect of salt is due to the removal of moisture, and salt itself reduces or prevents the activity of the bacteria if more than 6% of salt strength is present (Azeza, 1980). The rate of reduction of loss by insect infestation through brining is directly related to the amount of salt up-take. In order to avoid infestation for up to three months, the salt concentration should be above the 2.5% level which meets consumers' acceptability.

The value of insecticides constitutes a temptation to the producers of fish products and it proved very difficult to suppress the practice completely. It was felt that what was needed now was to marshall existing knowledge on the subject and to design a programme for further research. A scientific basis would be provided for weighing the advantages and disadvantages of the use of various products and for decision making as regards either the banning of the practice in its entirety or, the adoption of a more selective approach under which the use of certain chemicals would be prohibited while that of others, - such as the more suitable pyrethrum - might be allowed and made available at subsidized cost.

During a survey conducted with a view to identifying the use or misuse of insecticides, the results confirm that landings of fresh fish were much less in November than in July. In November, there were only a few landings in the afternoon whereas in July, the amount of fresh fish brought ashore reached a peak at sunset, and smoke could be seen rising from all the compounds of Doro II. This seasonal pattern in the fish catch corresponds to the hypothesis that catches are highest when the Lake level is at its lowest (July) and the fish are confined to a minimum area. Afterwards, catches fall when the water rises and the fish disperse to spawn over the newly-flooded land. Thus 7 to 8 tons a day were landed at Doro during July and 3 to 4 tons a day in November.

From the information concerning the origin of the processed fish which is landed at Baga, the following points emerge:

- 70% of the packages come from three areas; Duguri, Chongole and Tetewa,
- Duguri accounts for 33%, mainly in cartons,
- Chongole accounts for 29%, mainly in sacks,
- Dichlorvos aerosols (Shelltox) was used in Duguri island to keep away flies from smoked fish collected on makeshift storage awaiting sales to "fatoma" (Grant, 1980).

From an examination of the names of place of origin, the conclusion is that over half the processed fish landed at Baga comes from Chad.

4.4 List of the Places Given as the Origin of the Fish Products

Processed Fish

Kulkime
Duguri
Bakin Fili
Doban Liwa
Deber Alhaji
Kofia
Sungali
Dabbon Gihla
Filin Zaga
Chukun Guda
Daban Jukun
Sahara
Muaram
Kankaya

Chongole
Baga Sola
Bol
Tetewa
Bandaram
Kindjeria
Duriram
Iseiram
Goliyo
Boulangwa
Cameroun
Kingallam
Arewa Bul

Fresh Fish

Kulkime
Dogon Fili
Dabar Shata
Filin Gemu
Filin Gida
Bundume
Daba Tiko
Daba Karu
Bakin Fili
Gazula
Libya
Kolera
Chendu

Kudu
Zabbon Orziki
Bantegi
Tumbu Magaji
Rubundu Kiya
Bakin Tonki
Manbila
Tuno
Tungan Yashi
Loukou Shelwara
Alkaira
Raga
Filin Mariya

In all these fish landing sites, processors adopted a number of techniques to reduce post harvest losses.

When the suspicion arose that insecticides have been used indiscriminately in the industry, the Institute's Board approved a research programme to assess the extent of their use or misuse. Positive identification of the presence of insecticides in extracts of fish bought in March 1984 (which is the onset of the hot season) was obtained. Extracts were also analysed of fish caught during the cold season (October 1983). Below are the GLC analyses for single batches of *Lates niloticus*.

Products(s): Smoked *Lates niloticus*
Pesticide: Gardona
Column: 1ft 10% - 1 + 4% PDEAS on Gas Chrom Q 80-100 #
Column Temp. 210°C
Retention Time: 3.8 min. at 60 cm^3/min

Origin: Bol. Chad
Date of analyses: 26/3/84
Detector: FDP (melpar) CP
Atten: 4×10^4
Recover (r) = 90%

Corrected for Recovery: $r = \frac{(K) \times 100}{V} = 28.25$ ppm value for Gardona in sample

4.5 Conclusions

(i) light brining has only a minimal and temporary effect on insect infestation and insect development, and cannot be seen as an effective way to reduce spoilage, although the experiments were not conclusive;

(ii) very light brining (up to 1%) may attract beetles;

(iii) linght-brined fish were firmer than the unbrined controls, leading to reduced chances of breakages;

(iv) there is a great difference in the degree of infestation between individual pieces of the same species of fish;

(v) damage during the initial five days is minimal but as larvae consume three times their body weight per day the total damage after 15 days infestation is very extensive.

4.6 Suggestions

To prevent losses in processed fish such as is discussed here, the following points need attention:

(i) Drying: must reach a low enough moisture content for storage and must also be as fast as possible. Forced drying or hot-cooking is preferable to sun-drying but if sun-drying must be used, as with putrefied fish, there are several ways to improve the drying rate and the susceptibility to attack during drying. Blow flies do most damage whilst the fish is wet. The origins of insect attack are surfaces and structures.

(ii) Screening: Infestation is much reduced by screening the fish from fly attack, and screening the drying area from *Dermestes* attack. In all the fish landing or processing sites visited only in Baga Doro I was screening seen in operation.

(iii) Protection of Structures: The larvae of *Dermestes* often bore into wood which thus constitutes a source of residual infestation. Regular inspection of affected timbers and chemical protection should be carried out by extension workers.

(iv) Smoking: In general this reduces infestation and spoilage of fish intended for distant Southern Nigerian markets; refrigeration is unavailable. Smoking needs to be carefully controlled; it limits consumers' acceptability of products and can make products very brittle.

(v) Salting: Salting reduces the growth of the beetles throughout the storage period. Brining also gives some protection against microbial activity and thus reduces off-flavours.

(vi) Packaging: The products should be protected during storage and transport from moisture absorption and insect entry. If the product is well-dried and free from insects initially, then multiple liners in the sacks are beneficial. One of the commonest sources of infestation is from infested packaging.

(vii) Storage hygiene: this is very important because the control of insects in the fish product is dependent mainly on prevention of initial attack; thus the reduction of cross-infestation is vital.

(viii) Transport hygiene: important for the same reason as (vii). Also, it is vital that transport of dried fish is as fast as possible.

(ix) Chemical control: in view of the possible toxicity of many insecticides, the recommended pesticide is pyrethrum synergized by pipernoyl butoxide. This chemical is rapidly broken down by sunlight so it cannot be used effectively during sun-drying. But could be used effectively if sprinkled on the fish products already packed into cartons or sacks. We have to identify Gardona at a concentration of 28.25 ppm in one product. This compares to the accepted value of 3 ppm in cocoa seeds. Lindane has also been detected in other fish products. The pressure from manufacturers' sales agents is seen to be the cause of the use or misuse of insecticides in the industry.

The author feels strongly that the problems of safety combating losses in Lake Chad fish will be solved by a combination of two or more of the above points.

5. RECOMMENDATIONS

Improving the sanitary condition of fish landing and processing sites is strongly recommended to reduce insect attacks (their breeding grounds are destroyed by such improvements). Brining (with mild salt solutions) of fish before smoking or sun-drying is recommended. Re-smoking is strongly recommended at some locations. Firewood and experienced fish technologists are no longer scarce. One can now conclude, therefore, that a combination of re-smoking and packaging in reinforced containers are the best solutions for the reduction of losses.

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METHODOLOGY FOR THE ASSESSMENT OF LOSSES OF CURED FISH AND THE EVALUATION OF COUNTERMEASURES

by

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ABSTRACT

A methodology is described for the qualitative and quantitative assessment of losses of cured fish. It consists of gathering suitable background information, conducting a survey which assesses losses on a qualitative basis and then conducting loss measurement experiments on selected processes and/or distribution systems. Procedures for measuring, calculating and evaluating losses are given. Similar procedures can be used for countermeasure evaluation. It is strongly recommended that this methodology is applied to future studies on the measurement and prevention of losses in cured fish.

1. INTRODUCTION

1.1 The Need for a Loss Assessment Methodology

Losses of cured fish can occur during and after processing due to a wide variety of causes. FAO estimates have indicated that fish losses are among the highest for all commodities with an estimated 3 million tons (wet weight equivalent) per year of cured fish being lost out of an annual production of about 12 million tons (wet weight equivalent) with most of these losses occurring in tropical countries (US National Academy of Sciences, 1978). A reduction of these losses would play a significant role in boosting the amount of fish available for human consumption in many of the world's poorer countries and help alleviate dietary problems, such as protein deficiency.

Losses can vary considerably from place to place, from product to product and from season to season. Data on loss levels are needed which relates to particular situations to enable priority areas for remedial action to be identified as a first stage in a loss reduction programme. Until now, however, a methodology for loss assessment in cured fish has not been proposed; many of the estimates on levels of losses are educated guesses about a general situation. The purpose of this paper is to present a methodology suitable for assessing losses in cured fish during all stages of processing and distribution. It stems from the proposals made by FAO (1981) which were based mainly on work performed on losses in grains and other agricultural products. These proposals have been further developed and modified during field work conducted on a range of cured fish products in a variety of locations.

1.2 Types of Losses in Cured Fish

Losses have been defined as "nutrients from, and value of, fish which is potentially available for human consumption but fails to be consumed or sold as traditionally cured products" (FAO, 1981). Losses can occur in quantity of nutrients and product, in the nutritional quality of the product and in the quality of the product as perceived by the purchaser and consumer. In many cases these losses occur together due to a single cause or to several causes which may be related. In this paper losses in quantity, perceived quality and financial value will be considered. Losses in nutritional value are far more difficult to assess as relatively complex chemical analyses are required and even after these have been performed the data may be difficult to evaluate.

Losses can be caused by insect attack, physical damage, attack by rodents and other animals, chemical deterioration, such as rancidity, spoilage and attack by micro-organisms (see FAO, 1981, for a detailed review). These losses may appear as a loss in quantity by the destruction of the fish or by reducing its quality to the extent that it is considered unfit for consumption. Less serious damage or defects will lower the perceived quality of the product, which may or may not be associated with losses in quantity and nutritional value. All of these types of losses will have financial implications as they lower the price or saleability of the product, or simply decrease the amount of product available for sale.

1.3 The Need for Direct Loss Measurement

Measuring losses as directly as possible has very clear advantages in that margins of error will be minimized and that direct simple measurements are far more likely to be of use in extension work than a reliable indirect method, even if one could be developed. The limitations of indirect measurements, such as insect densities have been discussed by FAO (1981) and it was concluded that approaches of this type were unreliable, difficult to relate to actual losses and could be misleading.

The simplest way to study loss is to evaluate losses in quality as this can be performed by visual inspection. Processors and traders are generally aware of qualitative losses and observations used to evaluate quality will reveal the major loss causing mechanisms. A purely qualitative approach does, however, have severe limitations as it does not actually quantify losses so that it may not be possible to assess them unless they are clearly of little significance. Physical losses will, therefore, need to be quantified by direct measurement in situations where they are likely to be significant.

2. PROCEDURE FOR ASSESSING LOSSES

2.1 The Objectives of Loss Assessment

There are three basic objectives to be achieved during loss assessment:

(a) determination of the type of losses;
(b) measurements of the amount and extent of losses, and
(c) evaluation of the importance of the losses in nutritional and financial terms.

2.2 Background Information

As a first practical step it is necessary to obtain full and appropriate information about the fish resources (major species, quantities and seasons), methods of processing and distribution system because it is possible to anticipate the types of situation where losses can be high and hence direct the survey accordingly. If this information is absent, out of date or not regarded as being reliable, a survey may be needed to obtain more of the background information required. The amount and accuracy of the information available will, of course, be very variable, but the following gives an indication of what will be useful:

(a) geographical locations under consideration and their climatic features;
(b) the nature of the fish resources;
(c) the types of process in use;
(d) the amount of fish processed;
(e) the nature of the distribution system;
(f) packaging, storage facilities and transport systems, and
(g) the parameters set for acceptability (or grade and quality).

2.3 Use of Background Information

Wet seasons can facilitate losses due to insect attack and microbial attack of many types of cured fish. Hence wet season processing would clearly be a high priority for investigation during a survey. In other cases distribution centres where cured fish is stored may be identified; again these would merit a high priority for investigation, particularly for beetle infestation. Lengthy distribution of smoked fish would merit investigation for fragmentation. Any particularly large-scale curing activity would warrant at least a preliminary study in case some unexpected problems exist. The background information will in this way indicate the priority situations and locations where a survey should be conducted and what time of the year would be the most appropriate.

2.4 The Objectives of a Field Survey in Loss Assessment

Firstly, the immediate objectives of the survey must be defined. They may include one or all of the following aspects:

(a) to determine the amount of wet fish discarded prior to the start of curing;

(b) to determine the amount of fish lost at the curing stage, that is wet fish which fails to become processed into a satisfactory cured product;

(c) to determine the amount of cured fish which is produced, but lost during storage and distribution prior to consumption;

(d) to assess the financial consequences of losses of quantity and quality of cured fish;

(e) to evaluate the loss of nutritional value of the fish during processing and distribution (in addition to or separately from losses in the quantities of nutrients assessed in (a), (b) and (c), and

(f) to evaluate the nutritional consequences of losses.

2.5 Survey Methods

The practicalities of organizing a survey will depend so much upon local conditions and objectives that guidelines can be laid down only in a general way. The scale of survey embarked upon will depend very much upon what is already known and how much additional detail is sought. Since it is not practical to examine the whole industry, care must be exercised in the selection of those factors which are to be studied. The survey may be of one process, one distribution route, one type of cured fish entering one market. Whatever the approach care must be taken to decide how much measurement can be reasonably undertaken. It should be borne in mind that careful stratification of the stages should be done for the survey so as to accommodate the distinct variations which may be found between different regions and trades.

2.6 Quality Measurement in Assessing Losses

The aim of quality inspection and measurement is to objectively define the quality characteristics of the product. The type and extent of any defects are of particular relevance to loss assessment as these will indicate the cause of loss and may indicate the approximate extent of losses from a given cause.

Quality losses can occur before processing starts, during processing or during subsequent distribution. Hence quality factors which determine acceptance must be identified for all of the stages of the trade under consideration. The relative significance of the various factors will vary depending on the stage of the process under consideration and also on local preferences.

There are two major grades which have to be distinguished and defined for loss assessment, that which is acceptable and that which is unacceptable. More complex quality judgements are also made with products which are judged to be acceptable with the higher grades of products being by definition more desirable to the consumer (and as a consequence more desirable to the trader). This can be expressed in two ways, a higher price paid for higher grades or the lower grades remaining unsold while better products are available at the same price.

Objective quality measurement is difficult as quality perceived by the consumer or trader is such a complex judgement. Chemical analysis is not necessarily useful as a realistic indicator of quality; the most useful measurements depend on sensory assessments, such as appearance and odour. Some of the major quality factors are given below, but other factors could be significant for other products:

(a) belly burst (whole fish only);
(b) holes in the fish;
(c) proportion of bone and skin to muscle tissue;
(d) live insect infestation;
(e) discoloration;
(f) brittleness;
(g) size of pieces and their relative frequency;
(h) presence of moulds or decay, and
(i) odour defects.

Although identifying the type of defects is a valuable exercise in itself, for loss assessment the severity of the defects should also be defined as this will determine acceptability. A four-point scale based on that described by Watanabe and Dzekedzeke (1970) is recommended. The grades are defined below:

- "normal" refers to a condition that conforms to the usual, regular or accepted characteristics of the properly processed product;
- "moderate" refers to a condition that is fairly noticeable, but that is not seriously objectionable;
- "significant" refers to a condition that is readily noticeable and that considerably affects the appearance and/or eating quality of the product, and
- "excessive" refers to a condition that is readily noticeable and that seriously affects the appearance and/or eating quality of the product.

The quality of a sample of fish can be represented in a tabular form as shown in Table 1. If the objective is simply to describe the quality of a batch of fish a representative sample may be inspected. For loss measurement (see Section 2.8) when the fish must be divided into separate grades all of the batch being investigated must be inspected, but it may not be practical to record the quality assessments of the individual fish.

2.7 Physical Loss Measurement

Material can be lost in two different ways:

(a) it can be physically destroyed, for example, eaten by insects or lost as fragments which are not retained by the packaging in use, and

(b) it can be discarded (or used as animal feed or fertilizer) because it is below the minimum acceptable quality standard for human consumption.

In spite of these different mechanisms of loss the same simple principle can be applied to all situations. The process or distribution system (or both) are considered in their particular stages, the amount of fish at the beginning and end of each stage is measured and what is lost is calculated by subtraction.

2.8 Procedures for Physical Loss Measurement

A loss measurement procedure suitable for general use is described in detail below and summarized in Table 2. It must be noted that in many situations the position can be simplified as there will be only one or two quality grades with which to deal.

Firstly, at the start of a processing step it must be established how much material is there. This is done by the following procedure:

(a) inspect the fish for quality and select material of the required grade (see Section 2.6);

(b) remove a representative sample for chemical analysis (see Section 2.9);

(c) weigh the fish to be processed, stored or distributed;

The particular processing or distribution stage then proceeds. The procedure below is then performed at the end of the stage to establish how much material remains:

(d) inspect the fish for quality and segregate into grades (see Section 2.6);

(e) weigh the fish of the different grades separately, and

(f) remove a representative sample of the required acceptable grade for chemical analysis.

In a commercial process the amount of fish present after one stage and before the next is the same by definition; if this was not the case, the changes would constitute a further stage in the system. However, for loss measurement, fish must be removed for chemical analysis (and possible quality inspection if this is destructive) without appearing as a loss, hence the need to take weight measurements before and after the fish have been sampled (or the weight of the sample measured with the weight of fish before or after sampling). For the first stage the fish must be sampled before weighing and for the last stage sampled after weighing. Losses can then be calculated on a stage-by-stage basis using the methods described in the following sections.

Table 1

An example of a quality inspection table

No.	Fish length (mm)	Belly burst	Holes in sides	Hollow	Live infestation		Discard
					Fly	Beetle	
1	140	+					
2	115						
3	140		+	+	+		
4	105						
5	130						
6	160			++			+
7	110						
8	135						
9	125			+			
10	125	+		++			+
11	130						
12	105				+		
13	145		+				
14	110						
15	140		+				
16	165		+	++			+
17	130						
18	120		+	+	+		
19	105						
20	160			+			
21	115						
22	140						
23	120						
24	125						
25	130			+	+		
26	155						
27	110						
28	135						
29	125		+	++			+
30	115						
No. of fish		2	6	9	4	0	4
% sample with quality defect		7	20	30	13	0	13

Key: + moderate
++ significant
+++ excessive

2.9 Chemical Analyses Required for Loss Measurement

The sample representative of the whole of the batch of fish under consideration (i.e., including bone, scale, etc.) should firstly be ground up or minced as finely as possible to give a homogeneous material suitable for analysis. The moisture content should then be determined. Salted fish should be analysed for salt.

2.10 Calculation of Losses from the Data Gathered

2.10.1 General considerations

If cured fish was a uniform product of fixed composition then weight losses could be directly related to losses of nutrients. This is, however, not the case as cured fish consists of several components which can be put into four categories:

(a) edible flesh and nutrients, mainly protein, but including fat;
(b) moisture content;
(c) non-edible bony material, and
(d) salt (if added).

During processing and storage these components exhibit different characteristics and overall weight changes are the sum of all of the changes in the different components. The real area of interest is the proportional decrease in component (a) between two sets of measurements. This cannot be measured directly in all cases, but it can be calculated by correcting for the effect of the other components. Care must be taken in deciding which of the following correction factors are appropriate for the particular processing stages and products under consideration.

2.10.2 Effect of moisture content

Changes in moisture content can be corrected by expressing losses on a dry weight basis, otherwise weight losses will not relate directly to actual losses of nutrients. It is essential to correct changes in moisture contents in all cases where these are likely to occur, that is during processing and lengthy storage or distribution. In any event it is highly desirable to know what the moisture contents of the products are as this will affect the levels of the losses. The weight of dry matter can be calculated as shown below:

$$\text{The weight of dry matter } (f) = \frac{W(100-M)}{100} \qquad (1)$$

where W = weight of fish (measured)
M = moisture content, % by weight (from chemical analysis)

2.10.3 Effect of bone content

Another complication is that insects consume fish protein leaving inedible parts, such as bone, and also render portions inedible. By assuming that moisture corrected weight losses are due entirely to the loss of edible material it is possible to correct this factor. Previously edible parts rendered inedible, but which remain as part of the product would not appear as a loss unless physically removed before the weight is measured. The discarding of excessively hollowed fish will make this correction largely unnecessary, but for completeness the equations are considered below.

A correction factor can be calculated as follows:

$$\text{The proportion of edible solids } (k) = \frac{E}{W} \qquad (2)$$

where E = wet weight of edible fish (measured)
W = weight of fish (measured)

After (k) has been calculated the correction factor can be applied as below:

$$e = k \cdot f \qquad (3)$$

where f = weight of dry matter
e = weight of edible fish solid (moisture and bone free)

2.10.4 Effect of salt content

As salt content affects infestibility (and therefore losses due to insects) and the water activity (and hence the storage characteristics) the amount present should be determined. A correction factor can be applied, if it is shown to be necessary, by expressing quantities of fish on a salt-free basis.

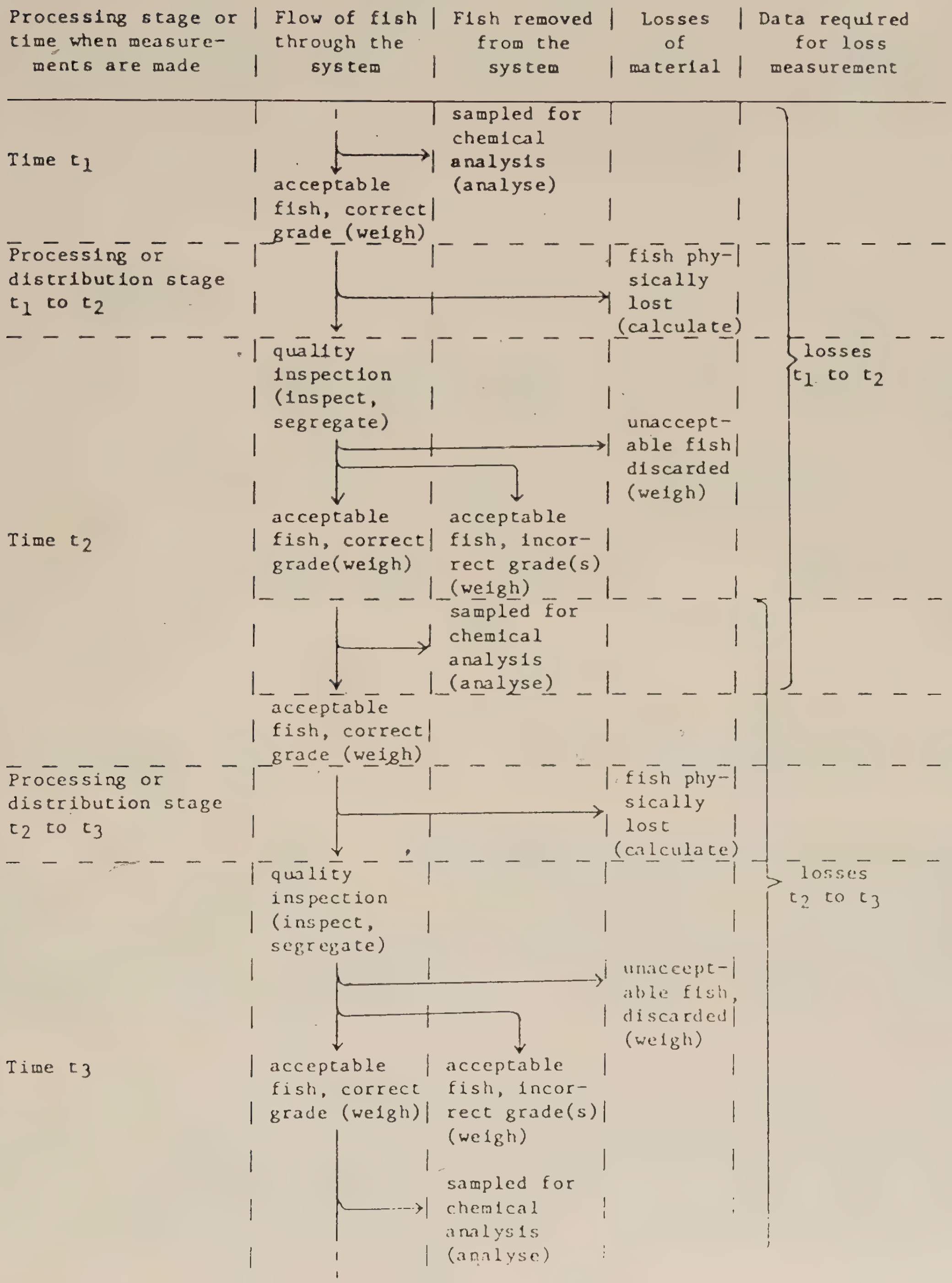
$$\text{The quantity of salt-free fish } (fs) = \frac{W(100-M-S)}{100} \qquad (4)$$

where M = moisture content, % by weight (from chemical analysis)
S = salt content, % by weight (from chemical analysis)

If necessary the bone correction factor (k) can now be applied.

Table 2

Loss measurement over two consecutive processing stages



Processing stage or time when measurements are made	Flow of fish through the system	Fish removed from the system	Losses of material	Data required for loss measurement
Time t_1	acceptable fish, correct grade (weigh)	sampled for chemical analysis (analyse)		losses t_1 to t_2
Processing or distribution stage t_1 to t_2			fish physically lost (calculate)	
	quality inspection (inspect, segregate)		unacceptable fish discarded (weigh)	
Time t_2	acceptable fish, correct grade(weigh)	acceptable fish, incorrect grade(s) (weigh)		
	acceptable fish, correct grade (weigh)	sampled for chemical analysis (analyse)		
Processing or distribution stage t_2 to t_3			fish physically lost (calculate)	losses t_2 to t_3
	quality inspection (inspect, segregate)		unacceptable fish, discarded (weigh)	
Time t_3	acceptable fish, correct grade (weigh)	acceptable fish, incorrect grade(s) (weigh)		
		sampled for chemical analysis (analyse)		

2.10.5 Percentage loss calculation for a single stage (general method)

Using the previous equation, the amount of edible material at a given time (t) can be calculated. This can be equivalent to the expressions f, e or e_s, depending on which correction factors have been considered necessary. The expression (e) will be used to denote the amount of edible fish material in subsequent equations, but this does not infer that it is not possible to assume that f = e in any particular case or that there is no need to calculate e_s in any particular situation.

The actual loss (l_s) over one processing stage, measurements being taken at times (t) and (t+1), is by definition $e_t - e_{t+1}$.

Hence the proportion lost (L) is given by:

$$L_{t-(t+1)} = \frac{e_t - e_{t+1}}{e_t} \qquad (5)$$

This fraction can be multiplied by 100% to give the percent loss for a single processing or distribution stage.

2.10.6 Percentage loss calculation for a single quality grading stage

Equation 5 can be used in all cases, that is in situations which:

(a) fish is physically lost, but not discarded;
(b) fish is discarded (or quality graded), but does not suffer physical losses prior to discarding, and
(c) fish is both physically lost and discarded.

However, in situation (b) if the chemical compositions of acceptable and discarded fish are similar, a simpler approach is to calculate the different proportions of product of various grades as below:

$$L_{t-(t+1)} = \frac{W^{u}_{t+1}}{W^{A}_{t+1} + W^{u}_{t+1}} \qquad (6)$$

where W^{u}_{t+1} = weight of unacceptable fish at time (t+1)

W^{A}_{t+1} = weight of acceptable fish at time (t+1)

This may be generally useful for fish discarded as being damaged physically (i.e., fragmented) or is mouldy or excessively rancid where there are no physical losses, such as those due to insects or fragments not retained by the packaging. In practice this method is useful in situations where quality grading at a given time is regarded as a processing stage by itself so that physical losses cannot occur.

2.10.7 Loss measurement during the early stages of fish drying: a modified approach

The initial processing stages present considerable difficulties to loss measurement. It is very difficult to measure moisture contents of a sample which truly represents the batch of fish which is weighed for loss assessment. Fish lose weight as they bleed and spoil; icing or freezing may affect the moisture content. Therefore, the analysis should ideally take place as rapidly as possible after sampling. It is even more unfortunate that even relatively small errors in the moisture content of the wet fish will give very large errors in the calculated losses due to the arithmetic involved.

To reduce errors in calculating losses, it may be advisable to start the weighing and sampling 1 or 2 days into the process rather than at the start so that a drier material is under consideration. It is important, however, that measurements start before losses become high and this time may be limited if blow-fly infestation is a serious problem. This approach has yet to be properly tested under field conditions.

2.10.8 The calculation of overall levels of losses of nutrients

Equations 5 and 6 will give figures for the proportion of edible fish solids lost at the various processing and distribution stages. It must be emphasized that the total percent lost is not the arithmetic sum of the percent losses at each stage. The equations for the calculation can be derived as follows.

Let the quantity of edible fish solids at time $t_o = e_o$, $t_1 = e_1$, etc.

The proportional loss between t_o and t_1 (using Equation 5) is:

$$L_{o-1} = \frac{(e_o - e_1)}{e_o}$$

Rearranging this expression $(e_o - e_1) = L_{o-1} \cdot e_o$

Whence $e_1 = e_o(1 - L_{o-1})$

$$\text{or} \quad e_1 = \frac{e_o(100 - L_{o-1}\%)}{100} \qquad (7)$$

Now in a four-step process, starting at t_o and ending at t_4, the flow of products through the system and the resulting losses at each stage are shown below:

$$\begin{tikzcd}
\text{Product} & e_o \arrow[r] \arrow[d] & e_1 \arrow[r] \arrow[d] & e_2 \arrow[r] \arrow[d] & e_3 \arrow[r] \arrow[d] & e_4 \\
\text{Loss (using Equation 7)} & L_{o-1} \cdot e_o & L_{1-2} \cdot e_1 & L_{2-3} \cdot e_2 & L_{3-4} \cdot e_3 &
\end{tikzcd}$$

Therefore total losses

$$(T_{o-4}) = L_{o-1} \cdot e_3 + L_{1-2} \cdot e_1 + L_{2-3} \cdot e_2 + L_{3-4} \cdot e_3 \qquad (8)$$

which can be divided by 100 to give the percentage losses.

This expression can, of course, be shortened or lengthened depending on the number of stages under consideration. The values of e_1, e_2, etc., can be calculated using Equation 7 on each step going through the system.

In practice it is probably easier to draw up an illustrative table showing losses at each stage and calculate overall losses from this rather than by applying Equation 8. This can be done by considering 100 units of product (e_o) at time (t_o) and calculating the amount of product remaining at each stage. The overall losses of nutrient can then be calculated using the equation below (for the four-step process considered previously):

$$T_{o-4} = e_o - e_4 \qquad (9)$$

Or more generally, for n stages:

percentage total losses of edible fish solids

$$(T\%) = \frac{(e_o - e_n)}{e_o} \times 100\%$$

$$\text{as} \quad e_o = 100 \quad (T\%) = 100 - e_n \qquad (10)$$

2.10.9 The estimation of the financial consequences of losses

Financial losses result from two causes, physical loss of product and loss of quality of product. The financial losses (V_{PL}) resulting from physical loss can be readily calculated from the percentage total losses of edible solids using Equation 11.

$$V_{PL} = \frac{W \cdot P \cdot T\%}{100} \qquad (11)$$

where W = weight of product at start of the stage under consideration
P = typical price of the product at the end of the stage under consideration

Financial losses resulting from a loss in quality (V_{QL}) can be calculated by subtracting the nominal value of the inferior products from its nominal value if it had been of the high quality. Hence, if after the grading the weight of product of highest quality equals W_{q1}, the second quality equals W_{q2} and the third quality equals W_{q3}, and the typical prices are P_1, P_2 and P_3, respectively.

$$V_{QL} = (W_{q1} + W_{q2} + W_{q3})\ P_1 - (W_{q1} \cdot P_1 + W_{q2} \cdot P_2 + W_{q3} \cdot P_3)$$

This simplifies to:

$$V_{QL} = W_{q2}(P_1 - P_2) + W_{q3}(P_1 - P_3) \qquad (12)$$

or as a percentage:

$$V_{QL}\% = \frac{[W_{q2}(P_1 - P_2) + W_{q3}(P_1 - P_3)]}{(W_{q1} + W_{q2} + W_{q3})P_1} \cdot 100\% \qquad (13)$$

Again this expression can be shortened or lengthened depending on the number of product quality grades under consideration.

The total percent financial losses (V%) is the sum of the financial losses due to physical destruction and the financial losses resulting from quality losses.

Expressed mathematically:

$$V\% = V_{PL}\% + \frac{V_{QL}\% \cdot (100 - T\%)}{100} \qquad (14)$$

where $V_{PL}\%$ = percent financial loss due to the physical destruction of the fish

$V_{QL}\%$ = percent financial loss due to the reduced quality of the fish still present

(100 - T%) = percent of the fish remaining at the final stage under consideration

2.11 Evaluation of Losses

In order to evaluate the significance of the losses it is helpful to derive overall "average" figures for the level of losses. Total losses in terms of quantity of product are simply calculated by multiplying the annual production by the figure obtained for the overall proportion of the fish lost. It must be emphasized that figures of this type are of little value when introducing countermeasures as in specific situations losses can range between 0 and 100%, however, average figures are required to assess whether the problems are sufficiently serious to justify remedial action and to indicate what level of resources should be made available.

A number of assumptions will probably have to be made in order to derive these figures. It is important that all the figures resulting from loss assessment and measurement, government production statistics, etc., which are used are quoted with their source. All assumptions should also be described and justified. In this way a future investigator can establish where these figures came from; by their very nature they will need periodic revision as circumstances change and more information is obtained.

3. DISCUSSION AND CONCLUSIONS

In general, surveying and quantitative loss measurement should be kept to the minimum consistent with the achievement of the stated objectives. There is no point in collecting large quantities of very accurate data for its own sake. What is needed is the magnitude of losses in the specific situations in which they are occurring. The net effect of this is that a very detailed picture of losses may not emerge until the major problems have been tackled and hopefully solved, but this should not restrain loss prevention work. Broad estimates based on reasonably accurate data from the specific situations should be regarded as being sufficient to justify additional work on loss reduction.

The complexity of the cured fish industry means that the investigator will need to use judgement in applying the methodology, but it does provide a much needed objective scientific means of identifying problems and evaluating potential solutions. By definition countermeasures must be shown to be effective in reducing losses. This can only be done by experimentally comparing countermeasures with existing "control" processes objectively using a suitable methodology. The quantitative and qualitative loss measurement method described here should prove to be a suitable way of evaluating the benefits of any proposed countermeasure.

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LOSSES OF TRADITIONALLY CURED FISH IN AFRICA

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ABSTRACT

A loss assessment methodology was applied to various practical situations and data on levels of losses of cured fish were obtained. In Senegal nutrient losses during the processing of braised and dried sardine were measured at 34.5% due mainly to blow-fly infestation but overall losses including discarded fish were probably over 40%. In contrast the Gambian traditional smokehouse operations did not suffer from any significant blow-fly problems and losses due to fragmentation of only 0.35% were measured experimentally. Dried fish stored for $5^1/_2$ months at Lake Turkana suffered losses due to beetle infestation of 15%, 7% and 1% for dried tilapia, labeo, and Nile perch respectively. The data confirm earlier general estimates that losses of fish are often high in Africa and show how variable losses can be depending on the exact circumstances of the industry. Because of this variability it is important that adequate loss assessment is conducted before and extension programme aimed at reducing losses is implemented.

1. INTRODUCTION

It is widely recognized that losses of traditionally cured fish can be high. One estimate is that about 3 million tons (wet weight equivalent) per year of dried fish is lost compared with an annual production of 12 million tons (wet weight equivalent) (US National Academy of Sciences, 1978). Losses are caused by microbial and insect attack, physical fragmentation and by chemical changes which alter the quality of the products (reviewed by FAO, 1981). Although data on losses is very limited, estimates for some situations do exist. Meynell (1978) reported that losses due to blow-fly infestation of sun-dried fish during the wet season averaged 12.7% and 7.5% in two processing centres in Malawi. Under adverse conditions losses of up to 30% could occur here. Doe et al. (1977) and Ahmed et al. (1978) suggested that losses of 25% and 30% could occur in Bangladesh due to blow-fly infestation of drying fish. Losses from beetle infestation have been put at 50% for the Lake Chad fishery (Rollings and Hayward, 1963) while Aref, Timbely and Daget (1965), reported losses of 23% and 9.1% from the same cause for brined fish stored for 5-6 months in Mali. Mills (1979) has recorded losses of 25-56% (depending on species) from the fragmentation of smoked fish distributed from Lake Chad.

A problem with some of the work quoted above is that the methods used to obtain the data were not reported. Some are probably no more than visual estimates which, although valuable, can be misleadingly inaccurate. While data such as that reported by Aref, Timbely and Daget (1965), Mills (1979) and Meynell (1978) were based on field trials and measurements, the methodologies used were not the same for all the studies and not always fully reported. A methodology for assessment of losses in cured fish has now been proposed in the previous paper (Wood, 1985) and applied to fish curing industries in several parts of Africa. Some practical problems were encountered but more data on the levels of losses in Africa were obtained as reported below.

2. LOSSES OF BRAISED DRIED SARDINE AT M'BOUR, SENEGAL

The background information obtained together with observations made during a brief visit indicated that in Senegal major problems were experienced during the curing of sardines. This was because the sardine fishing season in central Senegal largely coincided with the rainy season while the processes used gave little protection from blow-fly infestation and could easily be seriously disrupted by bad weather. A more detailed assessment of the most popular process in this area, braising and sun-drying to produce a product known locally as ketiakh, was undertaken to determine the significance of the losses of this product.

The process consisted of taking fresh intact sardines, arranging them on the ground, putting firewood over the fish and setting fire to the wood. The next day the cooked fish were skinned, headed, gutted and sun-dried for $1^1/_2$ days. The fish is still fairly moist after this drying period so that if it is not sold within 2-3 days it is redried before continued storage. For loss measurement the process was considered in the stages shown in Table 1. A batch of sardines was purchased and processed by professional fish processors and weighed at the beginning and end of each stage. A sample of 6 fish was removed between weighings. The fish was ground up and a pooled sample prepared for moisture analysis, the analysis being performed suing the oven method described by FAO (1981). The data obtained are given in Table 2. At the end of the trial some of the product had become fragmented. Although this is sold for human consumption in Senegal it fetches only about half the price of intact fish pieces resulting in the financial loss as shown in Table 2. The overall levels of losses can be calculated giving the data as shown in Table 3. The dry matter loss of 34.5% and financial loss of 43% which were measured during the processing indicate that due to losses occurring before processing starts, overall losses are probably over 40% with financial losses of nearly 50% (Table 4).

3. LOSSES OF SMOKED BONGA AT GUNJUR, THE GAMBIA

Although geographically close to M'Bour the type of processing techniques used at Gunjur were very different. Here the pelagic fish bonga (Ethmalosa fimbriata), which is fairly small but somewhat larger than sardine, is processed by smoking it intact until it is well dried. Although the wet season is a slack period for bonga landings, processing continues uninterrupted even during heavy rain storms as the processors use large enclosed smokehouses which are weather proof. The process consisted of five daily smokings after which period the fish was sorted into satisfactory products, fragments and fish which required further smoking as they were damp. Loss measurement was made at the final grading stage as the fish did not suffer from physical losses during processing, in particular blow-fly infestation was not a problem. The data obtained are given in Table 5.

The very low level of losses, 0.35%, due to fragmentation reveals how well adapted the process is to wet season conditions. Losses due to fragmentation may occur during onward distribution; although as much of the fish was sent to other countries in West Africa this could not be examined.

Table 1

Stratification of braised and dried sardine (ketiakh)
processing for loss assessment

Fresh fish in boat
LOSSES BEFORE PROCESSING

Fresh fish used for processing (t_0)
LOSSES DURING PROCESSING - COOKING

Cooked (charred) wet fish; skin, guts and head removed (t_1)
LOSSES DURING PROCESSING - DRYING

Dried fish at processing site (t_2)
LOSSES DURING STORAGE (1) - Fish stored for 3 days

Dried fish before redrying prior to further storage (t_3)
LOSSES DURING STORAGE (2) - Fish stored for 5 days

Dried fish about to be sold and consumed (t_4)
LOSSES DISCLOSED DURING QUALITY GRADING

Dried fish bought by the consumer (t_5)

Table 2

The measurement of losses between consecutive stages during the processing and storage of braised and dried sardine in Senegal

Processing stage, time and moisture content	Wet weight measured (kg)	Dry weight calculated (kg)[a]	% losses	
			Dry weight	Financial
Fresh fish used for processing (t_0) moisture content = 75.5%	122.30	Reliable data not available		
Cooked wet fish; skin, guts and head removed (t_1) (unable to conduct moisture analysis)				
1. Weight acceptable fish	58.74			
2. Weight acceptable fish (broken pieces)	3.02		5.0[b]	5.0[c]
3. Weight skin, etc., removed	37.16		0[d]	0[d]
Dried fish at processing site (t_2) moisture content = 26.8%				
1. Weight acceptable fish before sampling for analysis	37.99	27.8		
2. Weight acceptable fish after sampling for analysis	37.65	27.6		
Dried fish before redrying (t_3) moisture content = 33.1%				
1. Weight acceptable fish before sampling for analysis	33.75	22.6	18.1[e]	18.1[c]
2. Weight acceptable fish after sampling for analysis	33.59	22.5		
Dried fish at processing site (t_4) moisture content = 19.8%				
Weight acceptable fish before sampling for analysis	23.62	18.9	15.8[e]	15.8[c]
Dried fish bought by the consumer (t_5)				
1. Weight large fragments (first grade)	17.72			
2. Weight fine fragments (second grade)	6.13		0[f]	13.0[g]

Table 2 (Cont'd)

Notes (Equations refer to Wood, 1985, presented previously)

a/ Calculated using Equation 1

b/ Considered as a quality grading stage, loss equals the percentage of unacceptable fish of the total batch potentially available as acceptable products, calculated using equation 6

c/ Fish which was lost was regarded as having no significant economic value

d/ Not considered as a loss as these parts of the fish are not consumed with this particular product

e/ Calculated using equation 5

f/ No fish discarded as unacceptable

g/ Calculated using Equation 13; fine fragments sold at about half the price of the large fragments

Table 3

Overall measured level of losses of braised and dried sardine

Processing stage (see Table 1)	% loss in dry weight between processing stages (Table 2)	Quantity of fish (dry weight) left after each stage[a]	% loss in financial value between processing stages (see Table 2)	National financial value of fish after each stage[a]
Fresh fish (t_0)		100		100
LOSSES	5.0		5.0	
Cooked fish (t_1)		95		95
LOSSES	unknown		unknown	
Dried fish (t_2)		95		95
LOSSES	18.1		18.1	
Dried fish (t_3)		77.8		77.8
LOSSES	15.8		15.8	
Dried fish (t_4)		65.5		65.5
LOSSES	0		13.0	
Dried fish (t_5)		65.5		57.0
OVERALL LOSSES		100-65.5 = 34.5%		100-57.0 = 43.0%

a/ Calculated by considering 100 units of fish at time t_0 as described by Wood (1985). Overall losses calculated using Equations 10 and 15 for dry weight and financial losses respectively

Table 4

Assessment of losses of braised and dried sardine in Senegal

(a) Before processing (i.e., fish discarded due to rain interfering with processing)

The approximately 4-month sardine season in the Thies region (June to September) coincides with the wet season. As rainfall patterns can vary considerably from year to year it is difficult to give general figures due to losses rain interference but the following assumptions will be made as an illustration. The assumptions are made on the basis of impressions gained during the work and not based on established data.

1. 75% of the sardine used for ketiakh is caught during the wet season.
2. Ketiakh production is interrupted on an average of 2 days per week.
3. On average 50% of the sardine available for ketiakh production is dicarded when rain interrupts processing.

Hence $\frac{75}{100} \times \frac{2}{7} \times 50\%$ of the sardine catch will be discarded

= 10.7% loss of nutrients and financial loss.

(b) During processing and distribution

Taking the values found experimentally as "average" for the commercial situation for losses of dry matter = 34.5%; financial losses = 43.0% (as given in Table 3).

(c) Overall losses

Processing stage	Quantity of fish		% loss	
	dry wt. basis to = 100	financial value to = 100	of dry matter	financial
Before processing	100	100		
"Average" losses (from a)			10.7	10.7
Start of processing	89.3	89.3		
"Average" losses (from b)			34.5	43.0
Fish for consumption	58.5	50.9		
"Average" overall losses			41.5	49.1

Table 5

Losses of smoked Bonga

Quality grade of product	Weight of fish (kg)
Good quality products	173.2
Fragments and unacceptably broken fish	0.6
Fish taken for resmoking	10.2
LOSSES[a/]	0.35%

a/ Calculated using Equation 6 of Wood (1985), omitting the fish taken for resmoking

i.e., $\text{LOSSES} = \frac{0.6}{0.6 + 173.2} \times 100\% = 0.35\%$

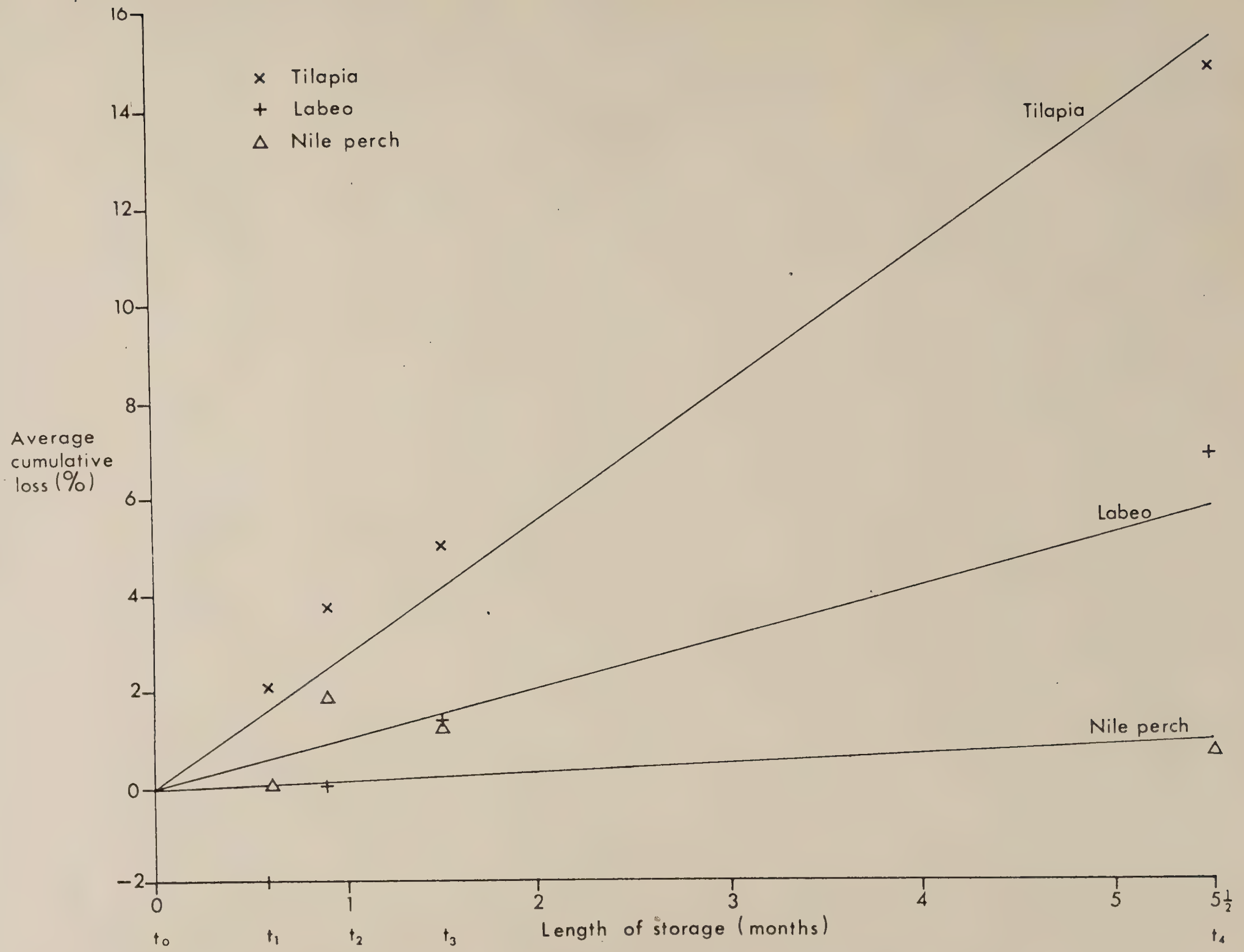

Figure 1 Losses of dried fish during storage at Lake Turkana

4. THE STORAGE OF SUN-DRIED FISH (LAKE TURKANA, KENYA)

Lake Turkana is a remote inland fishery which has a hot dry climate. Marketing of cured fish is difficult and storage periods can be long, over a year for certain products when there are particular problems in finding a purchaser. Beetle infestation is known to be a potential problem in finding a purchaser. Beetle infestation is known to be a potential problem when dried fish is stored and for this reason a pyrethrum/piperonyl butoxide insecticidal treatment is used commercially to treat products which had to be kept for any length of time. Loss measurement trials were conducted to see what losses would occur if no countermeasures were taken.

Untreated fish was stored for $5^1/2$ months in the commercial fish store at Kalokol, Lake Turkana. Split, sun-dried fish were bought at the Kalokol fish stall. Separate trials were conducted on 3 species of fish; tilapia (Sarotherodon niloticus), labeo (Horie sp.) and Nile perch (Longispirus sp.). They were stored in numbered hessian sacks which were arranged in random order in a row 2 sacks high. Stratification of the storage trial was performed simply on a time basis as distribution appeared to be fairly rapid once a market had been found. At various times the fish were inspected, the fish weighed before and after frass removal, and representative samples taken for moisture content analysis. The losses measured over the complete duration of the experiment are displayed on Figure 1. In $5^1/_2$ months storage about 15% of the tilapia was lost, 4% of the labeo but only 1% of the Nile perch.

5. DISCUSSIONS AND CONCLUSIONS

5.1 Blow-fly Infestation

Blow-fly infestation is known to be a problem during the sun drying of fish in wet seasons and the resulting losses have been shown to be high. The losses occurred very quickly, in just a few days, and infestation continued until a well dried product was obtained. Products which were sufficiently dry not to be attractive to adult blow-flies, and which therefore had no further eggs laid on them, were nonetheless heavily infested with larvae. Even heavy infestation was not always obvious as the larvae may develop in the interior of the fish. Hence infestation and losses may go undetected if fish is examined only on the surface. Similar observations have been made in Malawi on whole sun-dried small fish and in the Gambia on fermented and dried fish. In Malawi losses were found to average 23% for the 1982 wet season, but in one particular trial losses as high as 51% were measured (Tropical Development and Research Institute, 1984). It is clear that in some situations losses due to blow-fly infestation can be even higher than previous estimates would have indicated. Sun drying is a widespread traditional curing technique and this problem will affect the fish processing industries of many parts of Africa for at least part of the year.

Blow-fly infestation and the resulting losses do not occur when fish dries very quickly or is smoked to dryness. Very small fish which dry in 1-2 days are not usually attacked, as the eggs or newly hatched larvae die from desiccation (Walker and Donegan, 1984). Repeated high temperature smokings effectively prevent insect infestation. In the Gambia, which is generally wetter than the M'Bour area of Senegal and may have been expected to have serious problems, blow-fly infestation did not occur with bonga smoking. At M'Bour losses of fish are considerable, hence loss levels are very dependent on the type of processing being conducted.

5.2 Beetle Infestation

The data obtained confirm that the amount of damage done to a particular product is approximately proportional to the length of storage. In addition to confirming the observations of Aref, Timbely and Daget (1965), Proctor (1972) and Osuji (1974) that there are marked differences in susceptibility to attack by beetles depending on fish species, the data also indicate that some fish products are highly resistant to beetle damage under some field conditions. The reasons for these differences are not understood but may relate to the composition and texture of the products. Although beetle infestation is common and can cause large losses, it does not invariably do so, depending on the product and on storage time.

5.3 Fragmentation

In the particular case of smoked bonga losses due to fragmentation were low. Some loss may occur during distribution but the product appeared to be fairly resistant to fragmentation due to the very tough dried skin of the fish which contains the brittle flesh. In Nigeria, however, Mills (1979) identified fragmentation as a major cause of losses while in Zambia split smoked fish often suffers from this problem (Wood, unpublished observations) and it caused significant financial losses in Senegal. Hence while there are few data it does appear to be a major problem for some types of smoked fish.

5.4 General Discussions

Although surveys, estimates of losses made by on-the-spot observations and discussions with processors and traders are useful, they can be misleading. The process and locations chosen for the studies summarized here were identified during survey work as situations where losses could be high. Loss assessments subsequently revealed that the picture was a complex one and that although losses were very high in the case of braised and dried sardine they were low for the smoked Bonga even though the processes were conducted under similar climatic conditions and used similar fish. This in itself may suggest some possible countermeasures, for example the increased use of weather-proof smoking facilities in Senegal to counter losses due to blow-fly infestation. The data also indicate that when infestation by blow-fly larvae does occur it is likely to cause very heavy losses thus making it a particularly important area for the development of countermeasures.

For beetle attack losses occurred very much more slowly and in fact heavy infestation was found in products which had suffered relatively little damage. Hence preventative action should be specifically directed toward the products most at risk, that is the susceptible products which are stored for a long time. Much of the dried fish produced in Africa, and elsewhere, does become infested with beetles but it is only in specific situations that these will result in serious losses.

Very little data has been published on fragmentation and again this is probably a serious problem only in certain places. Microbial attack of cured fish does not appear to be a major problem in Africa; losses due to spoilage can occur prior to processing during wet weather but in normal commercial practice little of the fish which is cured is discarded due to spoilage. Other quality factors such as rancidity and grit contamination affect the commercial value, acceptability and probably the nutritional value of cured fish but are difficult to assess.

5.5 Conclusions

In spite of a growing knowledge on the basic causes of losses and their extent in some situations there is still much that is little understood. Losses may be low in situations where they might be expected to be high and vice versa as they can be very process and product specific. Hence there is a need for loss assessment of specific processes in specific locations to establish exactly where and how the losses occur and subsequently to assess the effectiveness of countermeasures.

Data obtained to date indicate that blow-fly infestation is likely to cause heavy losses whereas heavy beetle infestation may not necessarily lead to heavy levels of losses and assessment will be needed before introducing countermeasures. Losses of cured fish are often very high while the resources available to improve the situations are limited making it extremely important that loss prevention work is directed to the places where it is most needed.

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STUDIES ON THE FRAGMENTATION OF COOKED DRIED FISH

by

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ABSTRACT

Laboratory procedures for evaluating the tendency for cured fish to suffer from physical damage (fragmentation) have been developed. The processing parameters which affect the susceptibility of hot-smoked fish to fragmentation have been identified. Pre-drying the fish and initially smoking at a lower temperature before hot-smoking appears to be the most suitable processing method for reducing losses due to fragmentation in Africa.

1. INTRODUCTION

Hot-smoking is a popular method of processing fish, especially in Africa. The cooking effect of the process pasteurizes the fish and denatures its enzymes, thus preserving the fish. Although smoke contains some antimicrobial chemicals which are deposited on the fish, preservation is only short term (about 2 days under tropical conditions) unless some other means of preservation is used. Fish may be salted and/or dried to reduce the water activity, hence preventing microbial attack. In Africa hot-smoked fish is often unsalted and is dried if an extended storage life is required. Fish is sometimes redried or resmoked if it shows sign of decay or insect attack.

Dried fish, especially fish which has been hot-smoked, can be brittle and liable to fragment during handling and distribution. The simple inexpensive packaging materials in general commercial use often give the fish little protection from physical damage and may not retain small fragments. Also there is often a consumer preference for whole fish or large pieces hence small fragments represent a financial loss for the processor and trader. There is some evidence that appreciable amounts of fish can be lost due to fragmentation and that this may be a major cause of losses in some inland African fisheries where hot-smoking and drying is a popular method of processing (reviewed by FAO, 1981). For example, Mills (1979) measured losses of 25 and 56%, depending on species, during the distribution of hot-smoked dried fish from Lake Chad to Southern Nigeria. Moes et al. (1980) suggested that losses of 35% due to fragmentation were typical of this trade.

Hoffman et al. (1977) had suggested that better temperature control is required during traditional hot-smoking procedures in order to avoid the nutritional damage to the product caused by excessive temperatures. It has also been suggested that if well dried smoked products which do not fragment are to be produced, then lower temperatures than those used traditionally are desirable (FAO, 1981). Salt has been used in field studies to counter fragmentation of smoked fish from Lake Chad, Nigeria. Mills (1979) lightly brined fish before smoking and reported that this treatment decreased the amount of fragmentation observed during distribution. Salt is infrequently used in inland African fisheries due to high cost, lack of supply and unfamiliarity (hence limited acceptability) among consumers (FAO,1981). Light salting was regarded as a practical countermeasure whereas heavy salting was probably too expensive and unacceptable to consumers. It has not, however, proved possible as yet to confirm these findings (Moes et al., 1980; FAO, 1980).

There are clear practical difficulties in studying fragmentation in relation to the processing conditions used. It is very difficult to scientifically monitor and control the processes given the often rudimentary nature of the smoking kilns in commercial use. Hence significant batch-to-batch variations might occur making comparisons difficult under field situations. Arranging for commercial type trials involving transporting batches of fish along the usual distribution routes is time consuming and cannot be controlled scientifically. The degree of fragmentation would depend on many factors other than the physical state of the fish, for example the state of the roads and the packaging material used. Hence only direct comparisons would be worthwhile, thus making investigations slow and costly.

The purpose of this paper is to describe a simple laboratory procedure developed to assess the relative tendency for fish samples to fragment (fragmentability). The paper then describes the effect of various processing parameters on the fragmentability of fish and hence identifies some possible countermeasures for reducing losses of this type.

2. MATERIALS AND METHODS

Fragmentation experiments were conducted in the UK using the temperate water fish species, whiting (Merlangus merlangus). Fish were frozen and stored at -30°C for not more than 3 months before use. Fish were processed by thawing, heading and splitting. Brined fish were soaked in a 10% salt solution at ambient temperatures (16-18°C) for 1 hour. After brining the fish were rinsed briefly in fresh water and allowed to drain. In another experiment samples were dried at 25°C for various lenghts of time to partially dry the fish before subjecting them to the standard cooking procedure described below.

Fish were cooked and dried on horizontal trays in a Torry mini-kiln (Afos Ltd., Hull, UK). Temperatures were measured using a Grant temperature recorder (Grant Instruments Ltd., Cambridge, UK). Cooking was carried out by setting the heater to its maximum (110°C) and allowing the kiln to warm up for about 30 min. The temperature at the fish surface was monitored and it typically rose to about 55°C within 10 min of being placed in the kiln, 60°C in about 1 hour and reached a maximum of 85°C at the end of the cooking period. After a period of cooking (6 hours), the fish were dried to the required moisture content at 25°C, rising to 40°C when the fish were nearly dry. Uncooked fish were dried by the same method but without the cooking stage. The fish in a particular batch were left for 1-2 days for the moisture levels to equilibrate with one another before conducting any drop tests. This was necessary as the thickness of the split fish was variable, giving rise to uneven moisture contents at the end of the drying period.

Fragmentability of the fish was assessed by subjecting samples to a standardised mishandling procedure (drop tests). Three split, beheaded, dried fish were placed in a thin polythene bag and subjected to 20 perpendicular drops of 1 m, "front end" first onto a hard floor. Fragmentation was assessed by progressively removing fragments of specific sizes and reweighing the remaining sample. Fines were removed by sieving through a wire mesh (mesh size 6 mm^2) and fragments were sorted on a length basis progressively removing pieces of 30 mm and smaller, 30-100 mm, and over 100 mm (that is, fish which were largely intact). The weight of fragments smaller than 30 mm expressed as a percentage of the original weight of sample was taken as a standard measure of fragmentability as this gave the most reproducible data for this particular species.

Moisture contents of the samples were performed after fragmentability assessment and, in the case of the pre-dried fish, also before cooking. Representative sub-samples were taken, milled, and moisture content determined by drying in an oven as described in FAO (1981).

3. RESULTS

The fragmentability of uncooked fish, cooked and brined cooked fish dried to different moisture contents is shown in Figure 1. The effect of drying fish before cooking on fragmentability is shown in Figure 2, with the data on the moisture content of the samples used in assessing fragmentability being given in Table 1.

The results show that uncooked fish has little tendency to fragment even when dried to low moisture contents. In contrast cooked fish has an increasing tendency to fragment as the moisture content falls below 30%. Light brining has little or no effect on fragmentability at a given moisture content even though brined fish suffered from some gaping when dried.

Pre-drying reduced the fragmentability of the cooked fish, the lower the moisture content of fish at the start of cooking the lower the fragmentability of the final dried product. Some minor variations in the final moisture contents of the fish used for these assessments were observed but these did not correlate directly with the measured fragmentability; hence fragmentability data could be related to the moisture content of the fish before cooking.

4. DISCUSSION AND CONCLUSIONS

Although fragmentation can be countered by maintaining a high moisture content in the products, the fish would be rapidly attacked by moulds unless adequately dried. Hence the processor preparing unsalted hot-smoked fish which has to be kept for an extended period for distribution and marketing is in a dilemma. If the moisture content is kept high losses due to mould attack may be high but if the product is dried further fragmentation may be a serious cause of losses. Moisture content and the physical state of the fish may also affect losses due to beetle infestation; Osuji (1973) noted that smoked fish with a moisture content of below 10% generally showed little or no infestation but moisture contents between 13 and 16% were very conducive to insect infestation.

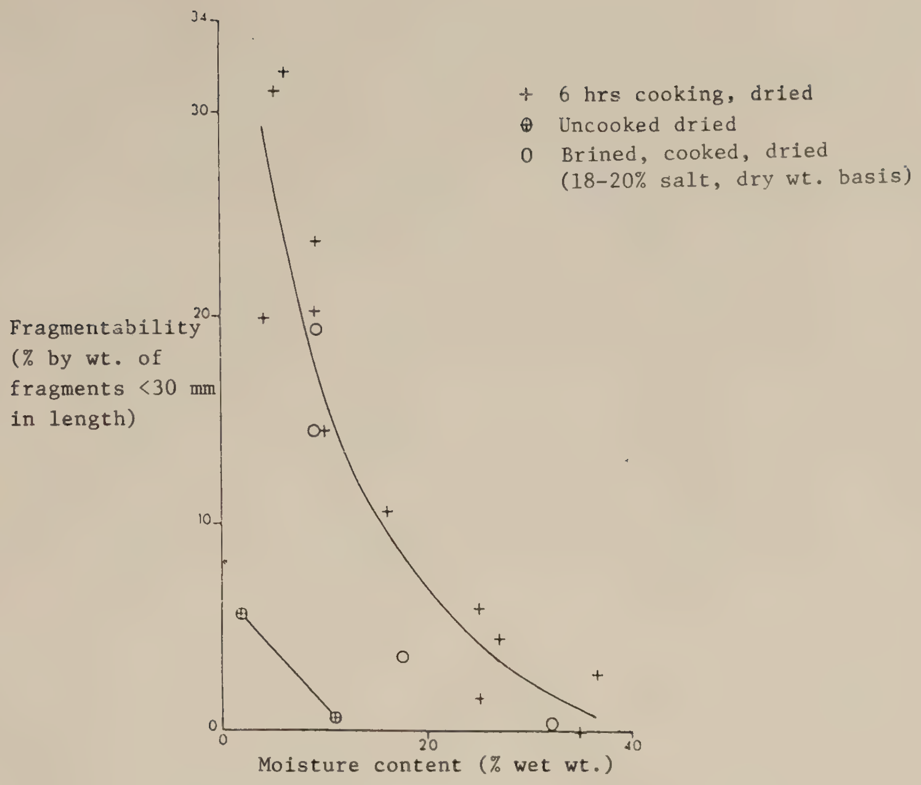

Figure 1 Effect of cooking and moisture content on the fragmentability of dried fish

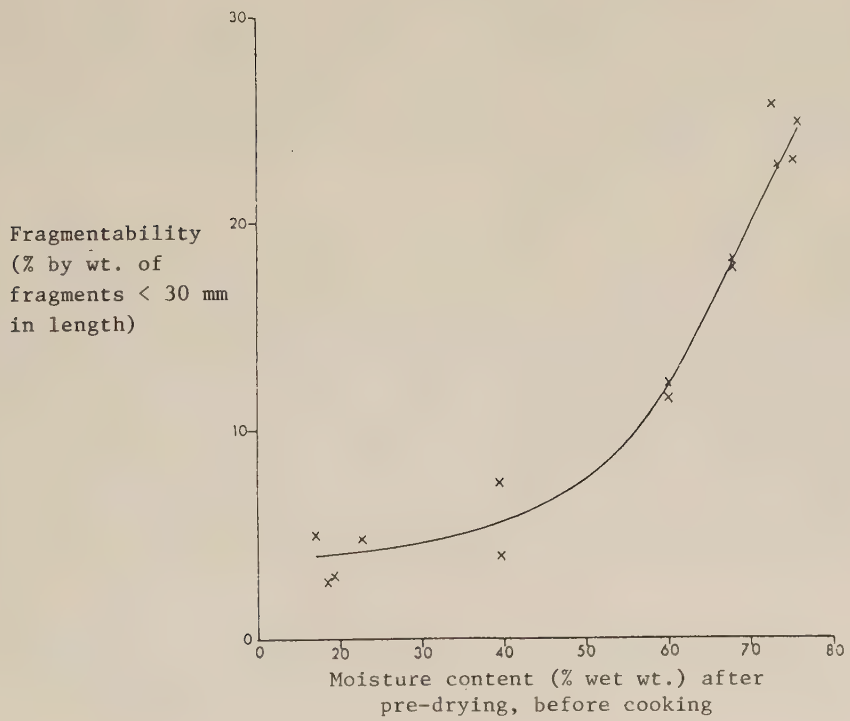

Figure 2 Effect of pre-drying on the fragmentability of cooked dried fish

Table 1

Moisture contents of pre-dried, cooked fish after pre-drying, and the moisture contents and fragmentability of the final dried products

Sample	Moisture content after after pre-drying at 25°C (%, wet weight)	Final moisture content (%, wet weight)	Fragmentability (% per fragments < 30 mm long)
1	75.7	2.2	25.1
2	75.3	3.1	23.3
3	73.7	4.1	23.1
4	72.4	4.3	26.1
5	67.6	5.1	18.4
6	67.4	5.7	18.1
7	59.8	5.2	11.7
8	59.5	5.7	12.3
9	39.4	1.9	7.6
10	39.4	2.0	4.0
11	22.5	3.4	4.8
12	18.6	3.7	3.0
13	18.5	3.3	2.9
14	17.1	3.8	5.0

The results indicated two methods by which adequately dried products resistant to fragmentation can be made. The fish can be smoked at low temperatures to prevent cooking (cold-smoked). This approach has distinct disadvantages as unlike hot-smoking there is no quick short term preservation. Also it seems unlikely that the simple kilns in normal use could control the temperature sufficiently well, nevertheless a reduction in the excessively high smoking temperatures often used will be beneficial in countering losses due to fragmentation and losses in nutritional value.

A second approach looked more promising, and is practised in some areas already (Watanabe and Dzekedzeke, 1970), namely partially drying the fish before hot-smoking. Figure 2 revealed that drying the fish to a moisture content of 50% before smoking reduced the fragmentability of the final product by over 50%. Significantly it showed that even a modest reduction of the initial moisture content greatly reduced the fragmentability of the hot-smoked dried product. Although too long a pre-drying period may not be acceptable as it may prevent penetration of smoke flavours into the fish, a short sun-drying period followed by a cold-smoking period before hot-smoking may give acceptable products resistant to fragmentation.

A third approach, namely the use of salt, had previously been field tested with inconclusive results. The data presented here is consistent with the findings described by Moes *et al.* (1980) that light brining makes little or no difference to losses due to fragmentation. The data does, however, reveal how salt can be used to counter this problem. Heavily salted fish does not need to be dried as much as unsalted fish for preservation thus hot-smoked fish with a moisture content of 30% (at which its fragmentability will be low) will have a storage life of about 2 months if its salt content is 15% (FAO, 1981; Poulter *et al.*, 1982). Although salting the fish prior to smoking may be appropriate in some areas, in the more remote inland fisheries in Africa where fragmentation of the products can be a major problem, salt is generally not available or is expensive. Hence in spite of having technical merits in many cases the use of salt may not be appropriate. Another approach which could be pursued is to improve the packaging for the products during distribution. It should also be noted that any measures which ensure that the raw material used for smoking is not spoiled before or after processing and which prevent or reduce insect infestation will also help to reduce fragmentation due to the physical deterioration of the fish.

The methods recommended above must be tested to counter losses in field situations to establish their commercial merits and suitability. As yet very few studies have been undertaken on losses of this type even though it has been shown to be a major problem in some locations. TDRI would welcome collaboration on the introduction of countermeasures to places where losses are high.

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NON-INSECTICIDAL METHODS OF REDUCING LOSSES CAUSED BY INFESTATION OF BLOW-FLIES (Diptera) DURING FISH CURING PROCEDURES

by

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ABSTRACT

Fish in the process of being sun-dried are extremely susceptible to infestation by blow-flies. In Africa the most commonly recorded Diptera in fish belong to the families Calliphoridae and Sarcophagidae. They are a major cause of post-harvest losses which can be very high when fish dry slowly and insect populations are high.

Blow-fly infestation can be reduced or even prevented by using alternative processing methods which are less susceptible to this type of damage. Fish is not attacked during hot smoking. Field trials indicate that salting the fish before drying gives protection although the exact relationships between salt content and susceptibility to infestation are unclear. Screening the fish during sun drying to exclude the ingress of blow-flies does not appear to be a practical alternative. Solar dryers have been shown to give some protection to salted fish but in other instances they have proved unsuitable for preventing blow-fly infestation of unsalted fish.

The role of non-insecticidal techniques is discussed in relation to the fish processing industry in Africa.

1. INTRODUCTION

Fish in the process of being dried in the sun can suffer very considerable losses due to blow-fly infestation. A paper presented previously has suggested that this problem is widespread during sun-drying under adverse conditions and it is one of the greatest causes of post-harvest losses of fish in Africa (Wood and Walker, 1985). The losses are most serious under wet or humid conditions when blow-fly populations are high and drying is slow. The fish are normally infested soon after landing, the larvae consuming the fish as it dries. Heavy losses can occur in three or four days and levels as high as 51% have been recorded in one particular loss measurement trial during the rainy season in Malawi (Tropical Development and Research Institute, 1984).

A number of species of Diptera have been identified infesting fish during the curing process. Most belong to the families Calliphoridae and Sarcophagidae. Infestation begins when the female adult blow-flies are attracted to the wet fish and lay eggs either singly or, more commonly, in batches. The small cream coloured larvae hatch and burrow into the flesh or move through the body cavities feeding on the fish as they develop. In extreme instances larvae will destroy all of the soft tissues leaving only the skin, scales and bones. On maturity the larvae usually burrow into the soil or sand beneath the drying fish to pupate. The adults then emerge to complete the life cycle (see FAO, 1981, for a more detailed review).

Small fish may dry too quickly for the continued development of the larvae. In this instance the larvae may perish in the fish without developing further or they may leave in search of other high moisture content food. Processes such as smoking and heavy salting are known to give fish some protection from blow-fly infestation while not all unsalted sun-drying products are equally susceptible to attack. Countermeasures such as the use of solar dryers and screening with physical barriers have also been suggested. This paper describes some recent studies and observations made by Tropical Development and Research Institute (TDRI) and discusses their potential uses in commercial situations.

2. MATERIALS AND METHODS

2.1 General Observations on Blow-fly Infestation

During the course of the experiments described below and in various other surveys and trials, observations and data were obtained regarding the mechanisms whereby blow-flies infest fish. In particular, studies were made in Malawi to determine how long the drying fish remained attractive to ovipositing females and what effect the size of the fish had on the incidence and degree of infestation.

2.2 Use of Salt to Control Infestation

Three field trials were conducted during the wet season in Malawi using small whole fish (Cichlidae) known locally as utaka (Haplochromis spp.) and chisawasawa (Lethrinops spp.). In each trial twelve 27 kg batches of fish were immersed in saturated brine for periods of between 30 and 120 min. Four batches of undipped fish were included in each trial as untreated controls. The dipped fish were then removed from the brine and put on raised racks to dry.

Two hundred fish were selected at random from each batch and examined for the presence of blow-fly eggs after 24 h on the racks and then re-inspected for larval infestation after 3 days of drying. On completion of the drying period the fish were examined for quality and the yield of acceptable fish was determined for each batch. Samples of fish were analysed for moisture and salt content using the methods described by FAO (1981).

2.3 Use of Solar Dryers and Screening to Prevent Infestation

Trials were conducted during the wet season in Malawi on the drying of small whole fish of the type used for the brining trials described above. Various types of dryer which relied on natural convection currents for ventilation and one forced-convection dryer were compared with fish dried on racks in the traditional way. Comparisons were made with regard to quality (including infestation levels on the third day of drying) of 30 fish selected randomly from the batch being processed. During these trials attempts were made to screen some of the dryers to prevent adult flies gaining access to the fish.

3. RESULTS

3.1 General Observations on Blow-fly Infestation

The typical timescale for infestation in Malawi and the Gambia was that oviposition commenced soon after the fish were caught and continued until about two days after the start of sun-drying, by which time the surfaces of the fish were dry. The eggs hatched in less than 1 day and larval infestation started to become significant during the second day of drying, reaching maximum levels on the third day, as shown in Table 1. It was not until after the fifth or sixth day, when the moisture content was approaching the final level of about 20%, that infestation declined. Only low numbers of mainly late instar larvae remained in the end product.

The levels of infestation and resultant losses were very dependent on the size of the individual fish being dried. In Malawi the fish ranged up to 195 mm in length and were considered in three size categories. The data obtained are shown in Table 2. Analysis of variance indicated that the differences between the data for small and medium fish were not statistically significant, but the data for large fish were statistically different from either of the other two groups at the 0.005 significance level. There was a general trend that infestation was greater as the size increased; while the large fish were often severely infested, sometimes all of them being damaged, it was exceptional for the small fish to suffer heavy damage and in some trials they remained completely free of infestation.

The data in Table 2 also show that infestation levels fluctuated from week to week. This was presumably due to prevailing weather conditions at the time although it was found that, contrary to expectations, high infestation levels did not correlate directly with wet weather and slow drying. Trials 2 and 3 were conducted during particularly adverse weather, drying taking 7 days instead of the usual 4 or 5 days. Trials 4 and 8, which suffered relatively heavy infestation, were in fact conducted during fairly good weather and drying was accomplished in 3 to 5 days. Perhaps significantly, the weather before these trials were started had been wet thereby facilitating an increase in the blow-fly population.

Blow-flies are commonly found breeding in fish waste at processing sites and also in adjacent latrine areas. It was noticeable in Malawi that where efforts had been made to improve sanitation there was normally a reduction in the incidence of blow-fly infestation of the fish.

3.2 Effect of Salt on Blow-fly Infestation

Salt appeared to inhibit egg laying on the fish as well as slowing down any microbiological spoilage of the fish as it dried. The relationship between salt content and dry weight losses is given in Figure 1 which shows that increasing salt content imparts greater protection to the fish until at 8% (dry weight basis) the losses are reduced to a negligible level. This finding was independent of the levels of loss in the untreated fish samples.

Table 1

Timescale of blow-fly infestation during sun-drying of fish (chisawasawa) in Malawi

Time of inspection during drying period	Percent of fish with larval infestation
Start of day 2	3
Start of day 3	37
Start of day 4	37
Start of day 5	37
Start of day 6	17
End of day 6	7
(End of drying period)	

Table 2

Relationship between the total-length of fish and the level of infestation on the third day of sun-drying

	% infested in each size group		
Size groups	Small (90-129 mm long)	Medium (130-159 mm long)	Large (160-195 mm long)
Trial No.: 1	0	18	50
2	25	44	83
3	14	39	60
4	64	80	100
5	17	22	100
6	0	53	58
7	19	13	67
8	60	86	100
Mean (Standard deviation)	25 (± 24.5)	44 (± 27.5)	77(± 21.0)

3.3 Use of Solar Dryers and Screening to Prevent Blow-fly Infestation

In Malawi the performance of the natural convection dryers in reducing blow-fly infestation was generally disappointing. Some of the dryers achieved temperatures which were sufficiently high to reduce infestation (up to 67°C in one cabinet-type dryer) but which also led to a slow cooking of the fish. This caused quality defects such as bellyburst and softening of the flesh. Designs which did not achieve temperatures high enough to cook the fish (up to 40°C) did not demonstrate any consistent control of infestation. In contrast, in Ecuador it was found that natural convection solar dryers did reduce blow-fly infestation without causing the type of quality defects associated with cooking the fish (Trim and Curran, 1983). In both studies blow-fly adults were able to gain access to the fish in the natural convection dryers. The forced convection dryer used in Malawi gave some control of infestation but it reduced the normal drying rate and therefore allowed some degree of spoilage to occur.

Attempts at screening some of the dryers in Malawi proved unsuccessful as flies invariably found a gap in the screen to gain access to the fish, but were then unable to escape from the dryer. While this could lead to dead adults accumulating in the dryer, perhaps giving the misleading appearance of an effective countermeasure, in fact it did nothing to prevent egg laying and subsequent larval infestation. Furthermore eggs have often been laid on the fish before they can be put in the dryers, so that even effective screening would not prevent infestation completely.

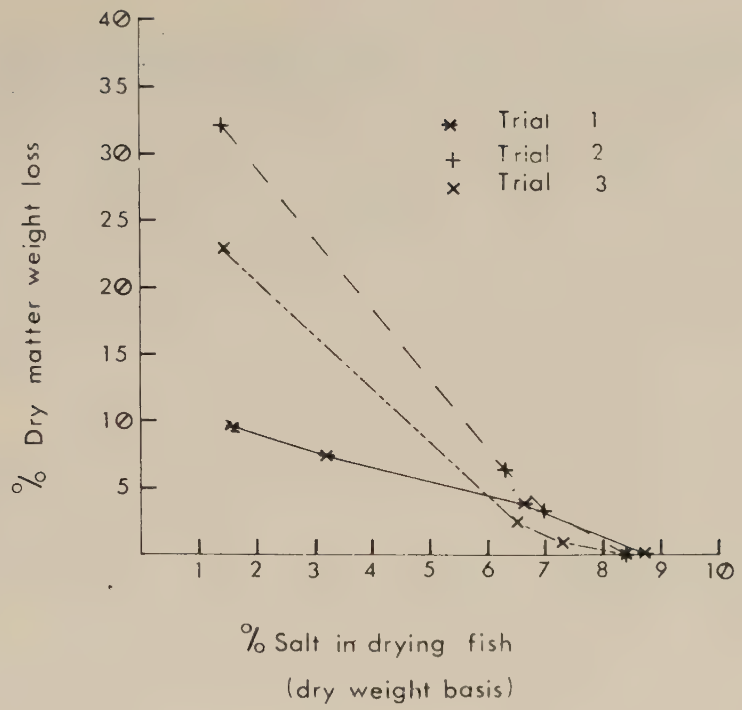

Figure 1 Relationship between salt content and the losses of sun-drying fish in Malawi

4. DISCUSSIONS AND CONCLUSIONS

4.1 General Observations on Blow-fly Infestation

The data in Table 1 indicate that larval infestation and losses continued even after the fish had become fairly dry and egg laying on the fish had stopped. The size of the fish, which affects the rate of drying, was extremely important. Fish which dried slowly could suffer larval infestation for a longer period and hence were more heavily damaged than fish which dried quickly. The larger fish also seemed to be more attractive to the adults as infestation levels were higher. The slow drying fish will spoil more than the fast drying ones which may make them more attractive to adult flies, although wet fish appears to be highly attractive for egg laying even when it is fresh.

Observations from other parts of Africa have indicated that the surface of the fish is an important factor in determining whether eggs are laid and whether these later hatch into larvae. In Malawi the mouth and gill areas were often chosen as sites for egg laying and in general the eggs successfully hatched into larvae. Products such as dried sea snails prepared in Senegal were attractive for oviposition but the eggs dried on the surface without hatching. This was probably because the product had a very smooth surface which dried quickly whereas infestation is apparently facilitated by surface features which retain moisture. Some dried fermented fish also had fairly smooth surfaces. In Senegal, blow-fly infestation was observed, but again in many cases dried unhatched eggs were seen on the smooth-surfaced fish which remained free from infestation. In contrast, the same type of product prepared under the much wetter and more humid conditions of the Gambia was often infested and damaged by fly larvae. Fish subjected to some types of process, such as smoking, are unaffected by blow-fly attack if smoking is continued until the produce has been dried (Wood and Walker, 1985). Hence there are considerable differences in the susceptibility of different products to blow-fly attack.

Whilst it is well documented that humid and wet conditions facilitate blow-fly attack, it was thought that this was largely the result of the extended drying period. The data presented here indicate that slow drying may be only one of the factors involved, since infestation can be at its highest when drying is relatively rapid. The heaviest losses resulted during warm dry weather immediately following a wet period suggesting that adult fly populations and activity are probably more important factors in determining the levels of infestation.

4.2 Effect of Salt on Blow-fly Infestation

The data obtained in Malawi suggest that salt is an effective method of preventing blow-fly attack. In some countries there is consumer resistance to salted products and salt is often expensive, particularly in inland fisheries. In Malawi it was concluded that it would not be cost effective to use salt even though preliminary trials did not indicate any consumer dislike for the salted product. Previous observations had indicated that salted fish were not susceptible to blow-fly attack, although there was a suggestion that infestation could occur during salting (kench curing) prior to salt penetration (reviewed by FAO, 1981). More recently it has been observed that some unidentified blow-fly larvae can infest fish which is fairly heavily salted. Hence, there must be some doubt as to whether the brining treatments in Malawi demonstrated an absolute protection for salted fish. If all the fish at a landing were brined, the degree of protection could be less as flies may lay eggs on brined fish in the absence of a more attractive place. Also, some fly species may be more tolerant of salt than others so that there could be an increase in the populations of such species if brining were introduced. At present there are insufficient data to indicate what level of protection a moderate salting procedure would give under commercial processing conditions.

4.3 The Use of Solar Dryers and Screening to Prevent Blow-fly Infestation

Although several trials have been conducted on the use of solar dryers their role in loss prevention has yet to be demonstrated. The natural convection dryers were not effective in reducing losses in Malawi, while the practicalities of using the forced convection type of dryer must be open to question on the grounds of relatively high construction and running costs. Factors such as the particular climatic conditions of Malawi, the type of fish being processed and the process itself may have contributed to the disappointing findings and it is possible that solar dryers may be useful in other areas and with different products. Some more recently completed trials conducted in the Gambia are described by Curran et al. (1985).

Screening of the fish during drying was difficult to achieve in practice. The fish needs to be periodically turned to ensure that the underside dries but fly screens would restrict access. The severe financial constraints imposed by the low price of fish products will also be an important factor.

4.4 Conclusions

Previously it has been shown that fish subjected to certain processes, particularly smoking, are not susceptible to fly infestation, so that an increased use of such techniques could reduce losses in some areas. This will, of course, be restricted by marketing requirements and availability of fuel. The use of salt is also effective, although it is still unclear how effective low and moderate salting would be in loss prevention. This will also be restricted by marketing requirements and the availability of salt. Countermeasures of this type need considerable research and development at the particular locations where they are to be introduced since, although they will reduce blow-fly infestation they will also influence the nature of the product, and hence processing and marketing.

It may be possible to use improved processes which still rely on sun-drying as the major method of preservation. Solar dryers and screening have yet to be proved as effective and practical, and there is some evidence that neither is likely to be suitable for commercial use in all situations. Investigation of the style of dressing of the fish in relation to infestation may warrant investigation at particular locations but once again care must be taken as the nature of the product may be changed.

In certain fisheries there may be considerable scope for the use of non-insecticidal methods; increased hygiene to reduce resident insect populations often would be a useful start. In many cases, however, losses may continue to be high as fully effective and practical non-insecticidal control methods will not be available. The haphazard misuse of insecticides on fish continues in some locations and will do so until effective alternatives are introduced. Hence more work is needed on identifying and introducing non-insecticidal methods of reducing losses where possible and on the development and introduction of safe insecticidal treatments as a last resort.

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NON-INSECTICIDAL METHODS OF REDUCING LOSSES DUE TO INFESTATION OF CURED FISH WITH BEETLE PESTS (COLEOPTERA)

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ABSTRACT

Cured fish are often infested with beetles during storage. The most common pests of sun-dried fish in Africa are _Dermestes maculatus_ Degeer and _Necrobia rufipes_ (Degeer) which, with others, can cause substantial losses. Infestation can be reduced by exposure to elevated temperatures although field trials indicated that treatment was labour intensive because dried fish did not readily conduct heat and required spreading in single layers. The effectiveness of heat disinfestation may be offset to some extent by increased losses due to fragmentation. Results from Kenya indicated that coating dried fish with oil delayed infestation by _D. maculatus_ without conferring lasting protection. Experimental work in Malawi and the United Kingdom demonstrated that increased salt content reduced the susceptibility of dried fish to beetle infestation.

The merits of the different countermeasures are discussed with references to their suitability for use in the commercial situations found in Africa.

1. INTRODUCTION

Beetle infestation can be a serious problem with cured fish which has to be stored in the course of distribution, especially where the fishery is remote from the domestic market, where catches are seasonal, or where there is an export trade. Fish are accumulated at production or distribution centres until sufficient quantities are available for transportation and a market has been identified. This may take several months depending on circumstances prevailing at the particular fishery. Storage periods are variable and sometimes unpredictable as they depend on complex supply and demand situations. Normally the longer the storage period the greater will be the danger of losses occurring. Unless appropriate countermeasures are taken the stored fish may be rendered unfit for consumption. The major pests are normally _Dermestes_ spp., especially _D. maculatus_ Degeer, _D. frischii_ Kugelan and _D. ater_ Degeer, with most of the damage being caused by the larvae (reviewed by FAO, 1981). _Necrobia rufipes_ (Degeer) is commonly found associated with _Dermestes_ spp. in dried fish although its status as a pest is uncertain. There are indications that, whilst _N. rufipes_ can occur as a pest in its own right, it can also be a predator of the normally more important _Dermestes_ spp.

Elevated temperatures are known to kill insects and have been used traditionally to control insects infesting stored grain. This technique can be used in the storage of smoked fish, although they may have to be resmoked every week. In Malawi some fish traders disinfest dried fish by immersing them in boiling water for a few seconds before redrying. Szabo (1968) has demonstrated that a solar box can be used to disinfest dried fish by raising their temperature. This paper describes some investigations on the effectiveness of solar boxes and sunning as means of disinfesting sun-dried fish.

In many countries it is common practice to coat some dried fish products with fish oil, apparently to improve the appearance and flavour, but also it is said in Senegal to inhibit beetle infestation. Trials were conducted in Kenya to gauge the effectiveness of this technique. Salt is known to inhibit insect infestation of fish (reviewed by FAO, 1981) but little information has been published on the precise levels of salt needed to significantly reduce losses. The relationship between salt content and the damage caused by beetle infestation was investigated in a series of field and laboratory trials described below.

This paper discusses the merits and suitability of these three countermeasures to the types of commercial situations which can be found in Africa.

2. MATERIAL AND METHODS

2.1 Heat Disinfestation of Fish

The sunning trials took place at Lake Turkana, Kenya, using split dried tilapia (Oreochromis spp.). The dried fish were obtained from a commercial fish store at Kalokol where they had been stored for four weeks. They were observed to be infested with D. maculatus.

Weighed batches of fish were spread in the open on a flat concrete surface and exposed to the sun from 10 a.m. to 3 p.m. The temperatures in the sun and in the shade under the fish were measured at hourly intervals using a thermocouple thermometer (Digitherm, Kane and May Ltd., United Kingdom). At the beginning and end of the sunning period 30 fish were selected at random for assessment of infestation and damage, and four of these were taken to determine moisture content with an Infratester (Foss Electric Ltd., United Kingdom) using samples ground in a domestic electric coffee grinder (Moulinex Super-Junior, France). This procedure was carried out on three different occasions. The sun-treated fish were put in sacks and returned to the store in order that losses could be monitored and compared with untreated controls.

An investigation to assess the suitability of solar boxes to disinfest dried fish was carried out at Lifuwu, Lake Malawi. Two solar boxes were constructed of plastered brick painted black on the inside and white on the outside. The walls were 0.7 m high and the top, which measured 1.3 x 1.7 m, was open. A wire platform at a height of 0.5 m supported the fish inside the boxes. One box had a cover of clear polyethylene sheeting stretched over a flat wooden frame.

Three trials were conducted in June 1982 to determine the suitability of these hot boxes for disinfesting small whole sun-dried chisawasawa and utaka (Cichlidae). In each, 25 kg of fish heavily infested with D. maculatus and N. rufipes were placed in four layers, approximately 90 mm deep, on the wire platform and exposed to the sun from 08.30 to 16.30 hours for one day. The temperature of the fish was measured at hourly intervals and the degree of adult insect infestation and moisture content of the fish were determined at the beginning and end of each trial.

2.2 Oil Treatment

The trials to investigate the use of oil were conducted at Lake Turkana using bottled cod liver oil because locally prepared fish intestine oil was not available at that time. The fish were coated with oil, using a paint brush, at a proportion of about 44 ml/kg of dried fish. After leaving them for a day to allow the oil to soak in, the fish were bundled into two piles each of 6 kg. The two control piles consisted of a similar quantity of untreated fish. The fish were stored for 45 days before the treatments were assessed by measuring levels of insect infestation and damage, and by measuring losses in dry matter using the methods described in a previous paper (Wood, 1985).

2.3 Use of Salt

Three trials to investigate the effect of salting were carried out at Lifuwu, Malawi, in which fresh whole chisawasawa (Cichlidae) of average weight 35 g and total-length 140 mm were soaked in saturated brine for different durations to achieve a range of salt contents. The fish were sun-dried on wire racks for between five and eight days to achieve a moisture content of between 16 and 21%. The dried fish were packed into hessian bags containing an average weight of 23 kg. Each treatment was duplicated and the bags positioned at random in a dried fish store for different periods of time between February and May 1982.

In the store the fish were exposed to infestation by D. maculatus and N. rufipes. On final assessment each fish was individually examined for signs of gross external beetle damage. Gross damage was defined as the presence of one or more large holes in the skin. This assessment would underestimate the real problem because no account was taken of minor skin perforations, internal damage, or the presence of live insects in or on the fish. Samples of chisawasawa were taken for the determination of fat by the Soxhlet method as described by Curran (1980), moisture and salt (total chloride) contents as described by FAO (1981). Approximately 5 kg of fish were taken from each treatment and cooked for use in taste panel assessments.

Salting trials were also conducted under controlled laboratory conditions at the Tropical Development and Research Institute, United Kingdom. The fish used were of a locally available lean temperate water species, whiting (Merlangius merlangus). Fish were prepared as single fillets with the skins left on. The fillets were brined for different periods and air-dried at 30°C in an Afos mini kiln. Prior to infestation the fish were placed in glass jars, approximately 60 g of fish in each, using five jars per treatment. The fish were allowed to equilibriate in a controlled regime of 27°C and 70% relative humidity until a constant weight was achieved. Four of the five jars were then infested with beetles, 10 adults and 10 larvae of D. maculatus or D. frischii per jar, the fifth jar being sampled for moisture, salt and fat content determination and retained as an uninfested control. Jars were covered with permeable gauze to allow the free passage of air but to prevent the escape of insects.

The fillets were then stored for about 9 weeks in the controlled temperature and humidity room until the most damaged sample was observed to have lost about 40% of its original weight. The insects were counted, and the frass was removed from the intact fish pieces which were then weighed. There were no significant changes in the composition of the control fish during the storage period.

3. RESULTS

3.1 Heat Disinfestation of Fish

The results of the Lake Turkana sunning trials are given in Table 1, which shows that total disinfestation was achieved on two out of three occasions. On the third the treatment had no effect because sustained high temperatures were not achieved. In general the result of the sunning was to drive insects from the fish, adults generally flying away soon after the fish were spread in the sun while larvae left the fish for the shade underneath. The exposure to sunlight also caused an appreciable loss in weight due mainly to loss of moisture (moisture reduced from 11-12% to below 10%) but also due to some fragmentation of the fish. The effect of the treatment on overall storage losses is shown in Figure 1. The rate of loss of untreated fish is assumed to be constant after an initial period of about ten days during which time the fish becomes infested and weight losses due to beetle attack will be negligible. Figure 1 indicates that although the effective disinfestation treatments led to a reduction in losses during subsequent storage this was offset to some extent by losses due to fragmentation which resulted from the treatment.

For the solar box trials in Malawi the temperature readings, being dependent on the weather, also varied from trial to trial. However, details of a trial conducted in June 1982 (Figures 3 and 4) provide a typical example of temperature fluctuations. The internal temperature of the fish at the top of the solar box covered with plastic sheeting rose to above 50°C for approximately one hour at midday under sunny conditions. The internal temperature in the bottom layer rose only to 38°C at the same time. A similar difference in temperature of top and bottom fish was observed in the uncovered solar box where temperature maxima of 47.5°C and 37.5°C were recorded.

The moisture content of the fish remained unaltered at a mean of 19%, wet weight basis, throughout the trials. In the covered box the total number of adult beetles also remained unchanged at a mean of 5/kg of fish but, whereas at the beginning of the trial they were distributed evenly throughout the fish, at the end they were found only in the bottom layers of fish and on the shaded walls of the solar box. In the uncovered box the number of insects was reduced to a mean of 2 adults/kg of fish which were foung only in the lower layers. It was observed that many adults left the fish and either flew or walked out of the solar box.

3.2 Oil Treatment

The data obtained on the infestation of oil-coated and untreated fish during storage are given in Table 2. This shows that oil coating had little, if any, effect on levels of infestation. The data on dry weight losses indicate that insect damage was inhibited initially but that after 45 days storage the treated fish had suffered an appreciable degree of damage. The dry weight losses data may exaggerate the actual differences as dust and grit adhered to the oil-coated fish, probably accounting for the initial increase in weight. The data on the percentage of damaged fish indicating that there is no long term protection resulting from oil coating is apparently more reliable.

3.3 Use of Salt

The results of the insect damage assessments of brined fish during field trials in Malawi are presented in Table 3. The results from the three trials are not directly comparable because they were not conducted simultaneously and the storage periods were of different durations; they do, however, show that insect damage levels decreased with increasing salt contents. It can be seen that, in each of the trials, the gross beetle damage was reduced by 97% at the highest salt content of 8.3% (dry weight basis). Lower salt contents also gave significant reductions in damage levels of between 65 and 96%. This good control of D. maculatus, and possibly N. rufipes, was obtained by a relatively light brining regime. Although Malawians generally prefer unsalted fish, results of preliminary taste panels indicated that the fish immersed in brine for 120 min, giving a mean salt content of 8.3%, would be acceptable on the local market.

The data on damage to fish in the laboratory trials are given in Figure 2. This shows that in general damage decreased as the salt content increased until a content of approximately 10% (wet weight basis) was reached at which point D. maculatus was unable to attack the fish. The results surprisingly indicated that very light brining increased the susceptibility of whiting to damage by D. maculatus, an observation which will be further investigated. D. frischii was more tolerant to salt as fish with a salt content of over 12% (wet weight basis) were still attacked to a minor extent. Light brining had little protective effect but did not stimulate attack by D. frischii.

Table 1

Qualitative effects of sun treatment of dried fish in reducing beetle infestation (Lake Turkana, Kenya)

Trial N° and date performed	% infested fish (larvae only)		Weather	Max. temperature measured (°C) during the treatment (10 a.m. - 3 p.m.)	% wet wt. loss during treatment
	before treatment	after treatment			
1 (22.4.83)	13	0	hazy sun thin cloud	40	5.8
2 (25.4.83)	30	0	sunny	48	6.5
3 (26.4.83)	20	23	hazy sun	39	5.7

Table 2

Effectiveness of oil treatment in reducing losses in stored dried fish

Storage time (days)	Numbers of Live Insects					
	17		32		45	
	Control	Oil treated	Control	Oil treated	Control	Oil treated
Dermestes spp.						
adults	29	38	44	66	52	89
larvae	17	13	7	14	10	61
Necrobia rufipes adults	3	0	5	16	6	13
Damaged fish (average % of total N° of fish)	40	24	60	53	87	93
Average losses in dry weight (%, cumulative totals)	1.3	-0.7	4.7	2.2	7.5	3.4

Table 3

The reduction of insect damage of stored dried fish in Malawi by brining

	Damaged Fish (per cent)				
Salt content (total chloride) (%, dry weight basis)	1.4[a/]	3.2	6.6	7.0	8.3
Trial A (23 days storage)	20.6	7.2	3.6	-	0.6
Trial B (85 days storage)	49.9	-	13.8	5.2	1.3
Trial C (75 days storage)	66.9	-	4.2	2.8	1.9

a/ Unbrined; the fish used had a total chloride content of 1.4%

4. DISCUSSION AND CONCLUSIONS

4.1 Heat Disinfestation of Fish

The highest temperatures achieved by use of sunning in Kenya and solar boxes in Malawi were 48°C and 50.5°C respectively. It is doubtful whether these temperatures would prove lethal to *D. maculatus* or *N. rufipes*. Paul *et al*. (1962) determined that the former insect could not develop at 40°C or above, but the larvae were only killed when the temperature was maintained at 50°C for more than 15 min. The higher temperature of 70°C for 40 min was reportedly required to disinfest cured fish in Mali (FAO/PNUD, 1970). No work appears to have been conducted on *N. rufipes* (FAO, 1981). It is possible that higher temperatures could have been achieved at other times of the year. However, there is a clear danger of only heating fish to around 35°C which is optimal for insect development, thus increasing insect damage.

The Malawi results emphasize the need to use single layers of fish when attempting to disinfest because dried fish appears to be a very poor heat conductor. Although higher temperatures were achieved when the solar box was covered, the advantage of this appeared to be lost by the cover preventing the insects from escaping. Whilst there is doubt about the ability to kill insects by the methods described it does appear that the adult insects can be made to move out of the dried fish by exposure in single layers to strong sunlight.

A disadvantage of this method is that even if it reduces insect infestation there may still be losses due to fragmentation. A significant proportion of the dried tilapia used for the sunning trials was very susceptible to fragmentation presumably because the fish flesh had started to cook during sun drying. This problem could be overcome by initially drying the fish in the shade before exposing it to the high temperatures obtained in the sun. Hence, if fragmentation occurs when heat disinfestation is introduced, an improvement in processing procedures should help solve the problem.

The loss of moisture and hence weight during treatment may lead to commercial losses if the fish is sold on a weight basis. A further problem is that it requires a considerable amount of handling of the fish and hence may be limited to small operations where space and labour are available. Additionally, it confers no lasting protection on the fish, although for long storage periods it could be repeated whenever infestation levels became heavy. Nevertheless, for the small-scale processor who has to store small quantities of dried or smoked fish for several weeks or longer, the technique should be reasonably effective and there may be few practical alternatives.

4.2 Oil Treatment

The oil did not prevent infestation but did delay the initial penetration of insects into the fish. The insect damage data indicated clearly that no lasting protection was given to the fish; periodic recoating may be desirable to give longer protection. The major limitations to the use of this technique are that it is labour intensive and hence only suitable for small-scale operations, it requires a large supply of inexpensive oil and it may affect the acceptability of the end product.

For the successful introduction of this technique its suitability to the scale of operation and acceptability to the consumer must be assessed for the particular circumstances. Traditionally fish liver oil is sometimes used when it is plentiful; for example, in marine fisheries where fish such as shark are caught. Shark have large fatty livers which yield large quantities of oil when sliced and boiled in water. Some fish species contain large quantities of oil in their guts and this may be the only type available in inland fisheries. However, if fish oil is not available then vegetable and nut oils might be usable although little work has been done on their effectiveness. They may also prove to be too expensive compared with the oil extracted from otherwise waste parts of the fish.

4.3 Use of Salt

If cured fish are to be stored for long periods, the production of a heavily salted product would prevent losses caused by beetle infestation. The main problems are that salt may be too expensive, particularly in inland fisheries, and that the consumer may not be familiar with or may dislike a heavily salted product. The laboratory data presented here indicate, however, that moderate salting confers significant protection from D. maculatus and D. frischii infestation, but that lightly salted fish can be attacked. The field data largely support this view, although the fish containing 3.2% salt (trial A) was not attacked very heavily, possibly suggesting that, when given a choice, beetles find unsalted fish more attractive than lightly salted fish. With marine fisheries the cost of salt will probably not be a limiting factor in its use but acceptability may be a constraint. Hence, although salt is known to be effective, its suitability in any particular situation must be considered in terms of need, cost and product acceptance.

5. CONCLUSIONS

The results show that it is technically possible to reduce losses due to beetle infestation by non-insecticidal methods, some of which are simple to use. Reducing insect populations by improved standards of hygiene and sanitation would in many cases also produce significant improvements. The major problems with these countermeasures are either that their effectiveness is limited or that in some commercial situations they may not be suitable, or both. In these instances insecticidal control measures should be considered as a last resort.

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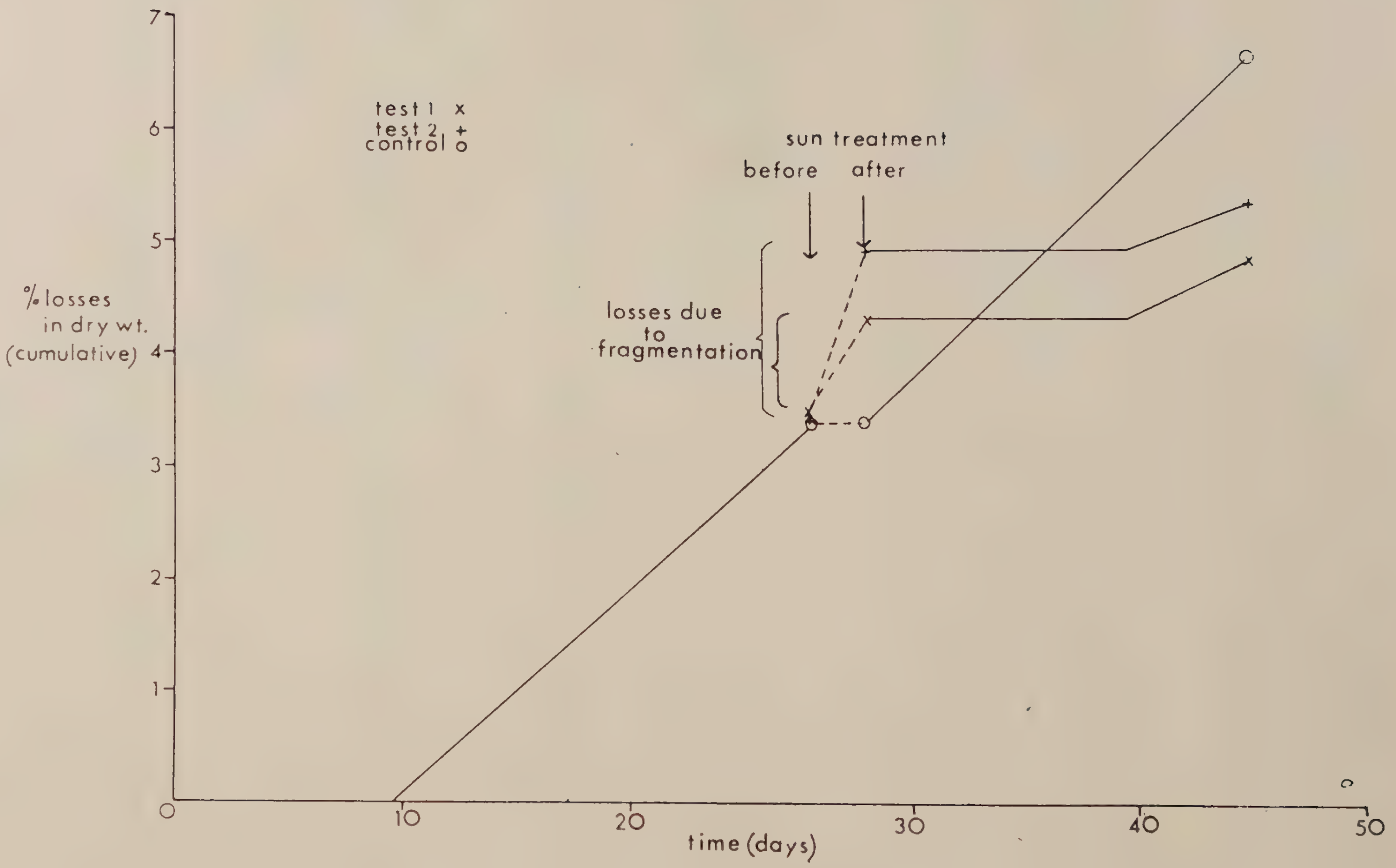

Figure 1 Effect on storage losses of sun treatment of dried fish (Lake Turkana, Kenya)

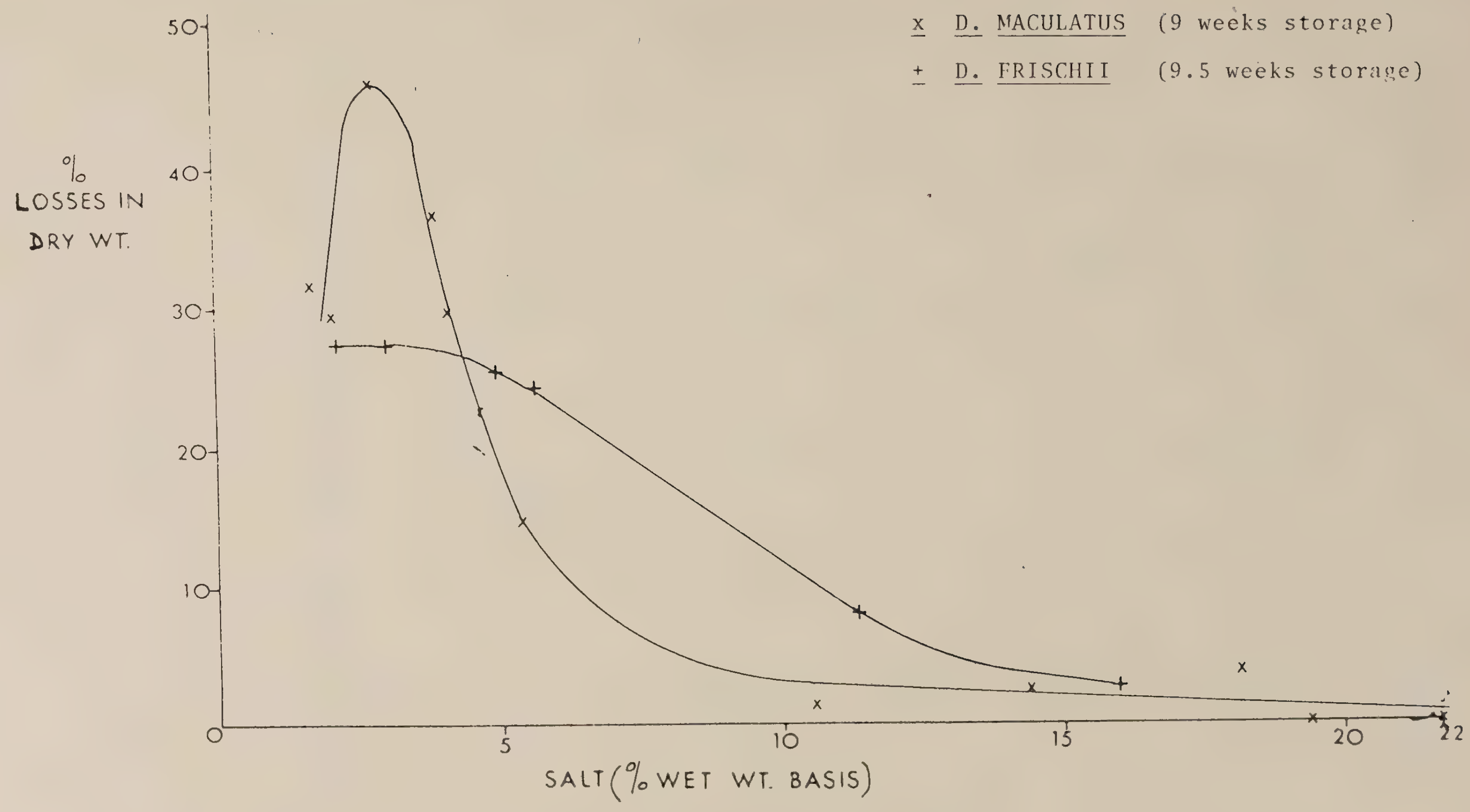

Figure 2 Susceptibility of dried whiting to attack by dermestid beetles

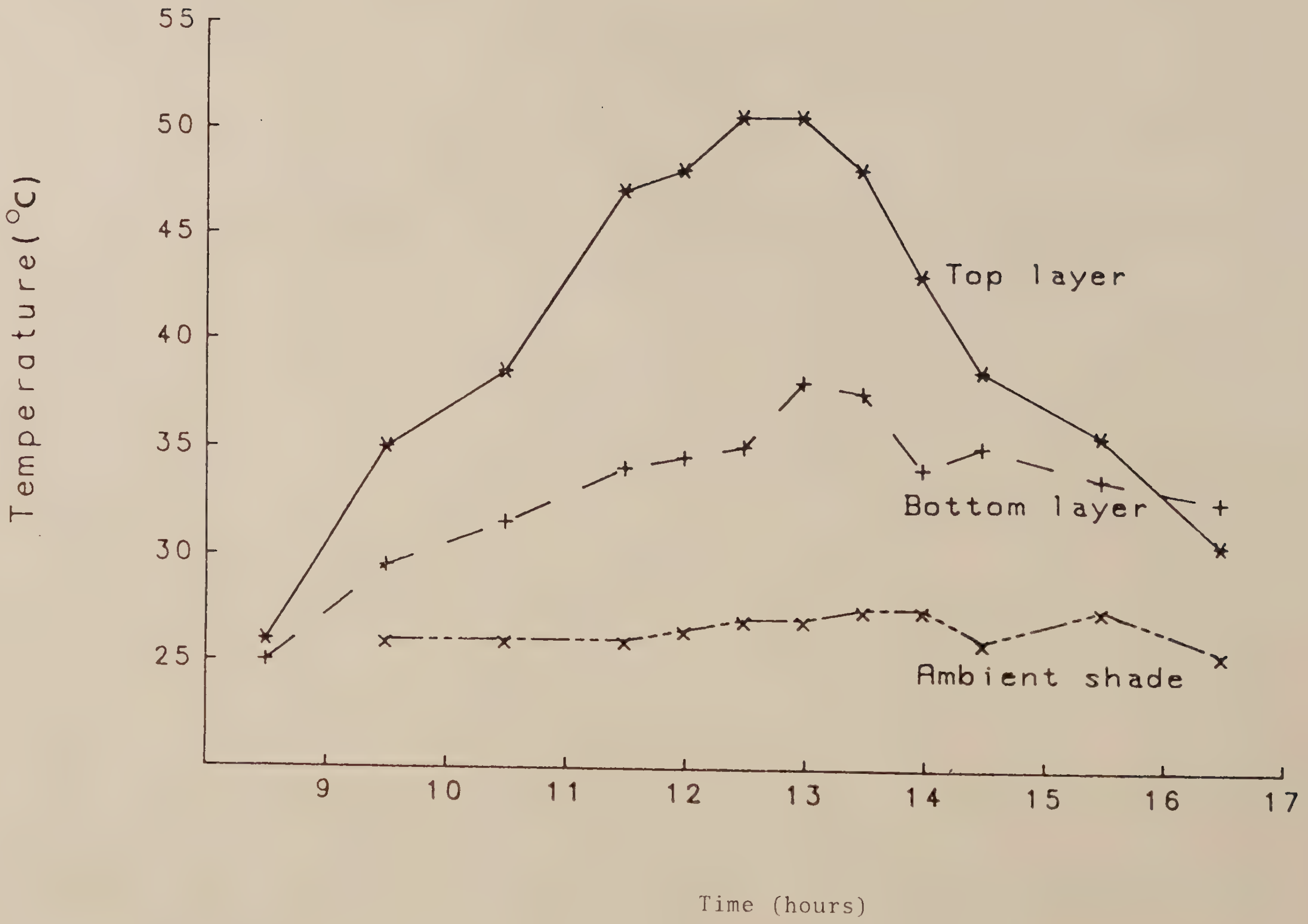

Figure 3 Temperature of dried fish in covered solar box

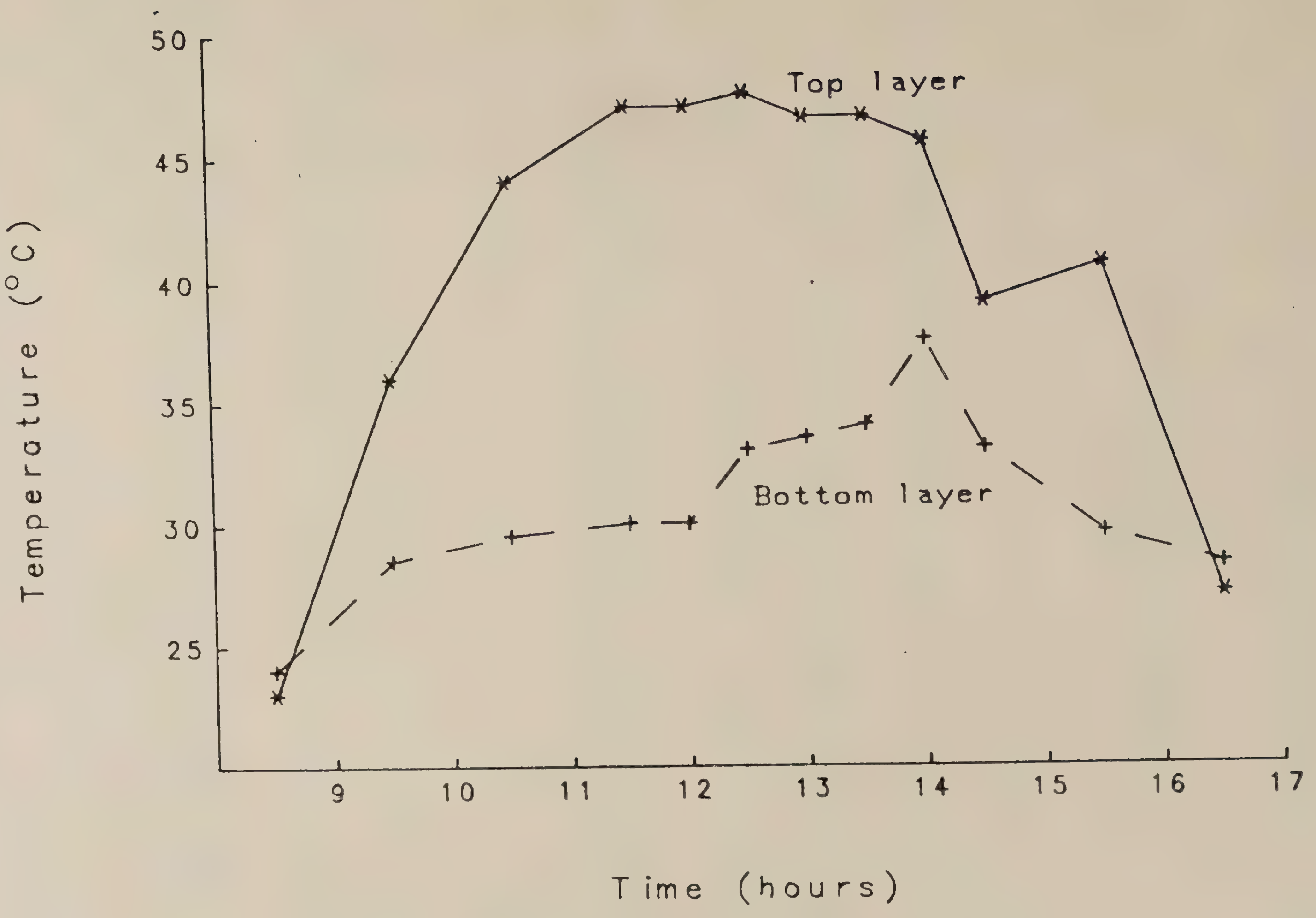

Figure 4 Temperature of dried fish in open solar box

PROTECTION OF FOOD COMMODITIES WITH INSECTICIDES

by

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ABSTRACT

Insecticides are now widely used for the protection of food commodities both before and after they are harvested. While insecticides have been used for many years throughout the world to protect grains, it is only comparatively recent that interest has been aroused in their potential use to protect cured fish from attack by blowflies or dermestid beetles. Fortunately, many of the principles developed in applying insecticides to grains can be used for the protection of cured fish especially with regard to the aspects of safety.

A major problem in the use of insecticides to protect cured fish is the lack of international clearance of any other than pyrethrum, synergized with piperonyl butoxide for this purpose. It is hoped that a current programme of research by TDRI will generate the data needed by FAO to enable maximum residue limits to be set for several of the more promising insecticides on cured fish. However, the fact that insecticides are routinely applied on a very widespread basis to cereals in advanced countries, such as Australia and Great Britain, as well as many African countries, should provide adequate reassurance that this, if carried out properly, is a safe way of protecting food which need not produce any hazard to consumers.

1. INTRODUCTION

Pesticides are now widely used for the protection of food commodities both before and after they are harvested. Protection may be needed against fungal pests, e.g., those which attack fruit or root crops, rodents or insects. The principles governing the use of pesticides for the protection of food are similar for all types of pesticide, but this paper is concerned only with insecticides which are used for protecting durable food, such as grain or dried fish from insect attack.

While insecticides have been used for many years throughout the world to protect grain, their potential use to protect dried fish from attack by blowflies or dermestid beetles has until recently been little exploited. Fortunately, many of the principles developed in applying insecticides to grain can be used for the protection of dried fish, especially with regard to the aspects of safety to the consumer. For example, the fact that insecticides are routinely applied on a very widespread basis to cereals in advanced countries, such as Australia and Great Britain, as well as many African countries, should provide adequate reassurance that this, if carried out properly, is a safe way of protecting food which need not produce any hazard to consumers.

2. TYPES OF INSECTICIDE

Insecticides may be divided into two groups on the basis of the way in which they reach the insect. The larger group is that of the "contact insecticides", which are solids or liquids exerting their toxic effect by direct contact with insects. The other much smaller group is that of the "fumigants" which work in the gaseous phase through dispersal in a confined space containing the insects. Some contact insecticides are sufficiently volatile to exert a lesser fumigant effect. The two fumigants now most widely used for the disinfestation of food (methyl bromide and phosphine) do not normally cause any problems with regard to possible contamination of food with toxic residues, although methyl bromide leaves residues of inorganic bromide, especially on materials which have high fat contents. Thus, for example, it is generally better to fumigate dried fish with phosphine. Fumigants do not provide any lasting protection, but are generally the most effective method of completely disinfesting consignments of food commodities. Contact insecticides, however, can be used to protect food from insect attack over quite long periods, extending to six months or more in some instances.

Contact insecticides which may be used for the protection of commodities may be divided into four main groups on the basis of their chemical composition:

(a) organo-chlorine compounds, such as DDT, HCH and dieldrin;

(b) organo-phosphorus compounds, such as malathion, fenitrothion and pirimiphos methyl;

(c) pyrethroids, such as natural pyrethrum, permethrin and deltamethrin;

(d) carbamates, such as carbaryl and propoxur.

Any insecticide which is applied to food commodities must have a low mammalian toxicity so that it does not constitute any potential hazard to the consumer, while at the same time being effective against insect pests. Only a very small number of products which are available commercially meet these requirements and can thus be recommended for direct application to food commodities. Most of these fall within the organo-phosphorus and pyrethroid groups; the use of the least toxic organochlorine compounds, e.g., HCH is now generally avoided, while carbamates are mostly either too toxic to mammals or insufficiently effective.

A further factor which limits the range of insecticides available for the protection of stored food is that only about 4 percent of the insecticides used each year throughout the world is used for this purpose. As it now costs as much as US$ 30 million to develop and market a new insecticide, it is not practicable in economic terms to develop new products specifically for the post-harvest sector, as the cost of research, development and registration could not be recovered by subsequent sales within the period of patent protection which is allowed.

3. TYPES OF FORMULATION

An insecticide formulation is a means of transferring an insecticidal chemical into a product which can be applied effectively, safely and economically. Insecticide formulations consist, therefore, of the chemical (generally known as the "active ingredient") dissolved in a liquid carrier or admixed with an inert solid material. Three types of formulation are commonly applied to food:

(a) emulsifiable concentrates: these are solutions of active ingredient in a solvent which is immiscible with water, but also contains a surfactant. The concentrate may be diluted with water so as to form an emulsion which can be applied as a spray or dip;

(b) wettable powders: these are dry powders containing the active ingredient mixed with an absorbant material and a surfactant. They are mixed with water forming a suspension which can be applied to the commodity by spraying or dipping;

(c) dusts: these are powders containing the active ingredient mixed with an inert material. They are applied to the commodity in the dry form.

The type of formulation which is used and its manner of application to the commodity depends on the particular circumstances. For example, if penetration into the commodity causes no problems or is even considered desirable, a diluted emulsion concentrate is best used. However, if a surface deposit is required then a wettable powder will be more appropriate. Dilute dusts are of particular value for admixture of insecticides with dry granular commodities, such as cereal grains.

4. INSECTICIDE RESIDUES

Even though the contact insecticides, which are permitted to be applied to food, are of low mammalian toxicity, only the minimum amount needed to provide adequate protection should be applied and any residues of insecticide remaining should be too low to cause any hazard to the eventual consumer of the product. Many countries now possess regulatory schemes governing the application of insecticides to food and these are in many cases based on the recommendations of the FAO/WHO Joint Committee on Pesticide Residues (JMPR), which meets annually to consider submissions to allow the use of particular pesticides on particular food. Before the JMPR recommends acceptance of the use of pesticides on food, it has to be assured that the product in question is both effective and safe to use, and sufficient evidence in the form of data of laboratory and field trials and toxicology must be submitted for this purpose.

The problem of pesticide residues on food products which are traded internationally, is dealt with by the Codex Alimentarius Commission through its Committee on Pesticide Residues (CCPR). The Commission is a joint body of interested countries, sponsored by WHO and FAO, which attempts to agreed common acceptable international standards of food hygiene. Submission to CCPR for clearance of the use of pesticides on food entering world trade are normally based on the recommendations of the JMPR. It takes many years for the recommendations of the JMPR to achieve international acceptance through the Codex Alimentarius Commission, due to the complex stepwise procedure which has to be adopted.

JMPR makes its recommendations in terms of the "acceptable daily intake" of the insecticide and the "maximum residue limit" allowable when the insecticide is applied in accordance with "good agricultural practice". These terms are defined as follows:

(a) acceptable daily intake (ADI) of a pesticide is the daily intake which, during an entire lifetime, appears to be without appreciable risk on the basis of known facts at the time. It is expressed in milligrams of the chemical per kilogram of body weight mg/kg (parts per million);

(b) maximum residue limit is the maximum concentration of a pesticide residue resulting from the use of a pesticide according to good agricultural practice directly or indirectly for the production and/or protection of the commodity for which the limit is recommended. The maximum residue limit should be legally recognized. It is expressed in mg/kg (parts per million);

(c) good agricultural practice in pesticide use is the officially recommended or authorized usage of pesticides under practical conditions at any stage of production, storage, transport, distribution and processing of food and other agricultural commodities, bearing in mind the variations in the requirements within and between regions and taking into account the minimum quantities necessary to achieve control, the pesticides being applied in such a manner as to leave residues that are the smallest amounts practicable and that are toxicologically acceptable.

The pesticide residue is taken as including any specified derivatives of the pesticide which are considered to be of toxicological significance, such as degradation and conversion products, metabolites, reaction products and impurities. Maximum residue limits are only set for pesticides for which it has been possible to establish an acceptable daily intake. However, temporary figures may be set for these, pending submission of further toxicological data to the JMPR. It should be noted that the rate of application of a pesticide to a food in accordance with good agricultural practice is currently independent of consideration of the acceptable daily intake or the pattern of consumption of the product.

However, concern is now being voiced that these factors should be taken into account in deciding maximum residue limits and it seems eminently sensible that this should be the case at least at national level. For example, if a staple cereal which forms a large proportion of the diet is to be treated, care will need to be taken to ensure that excessive amounts of residues of pesticide are not likely to be consumed. Conversely, residues of pesticides on a dietary component consumed in smaller quantities would institute less hazard.

The attached Table summarizes the recommendations (up to 1983) by JMPR for maximum residue limits for insecticides applied to a range of cereals and their products and other durable food. JMPR's recommendations in respect of those pesticides marked with an asterisk have also been accepted by the Codex Alimentarius Commission through its Committee on Pesticide Residues.

5. PROTECTION OF FISH FROM INSECT ATTACK

There are two distinct types of insect infestation which can damage fish. Firstly, there are blowflies which infest wet fish during the early stages of drying. Blowfly larvae can cause serious damage over very short periods. After the fish are sufficiently dry to prevent further damage by blowfly larvae, they may be attacked by dermestid beetles which, if undetected, will continue to cause damage right up to the time of consumption.

Protection from blowfly need only be for a short period until the moisture content of the fish is reduced to a level which is below that at which blowfly larvae survive. The only method of insecticidal treatment of fish currently recommended by JMPR, viz., the application of natural pyrethrum synergized with piperonyl butoxide was, in fact, developed for this specific purpose. The recommendation was based on data submitted by Norwegian workers in respect of the protection of drying codfish in the cool conditions of Norway and this bears little relation to anything that is happening in Africa or other tropical regions (WHO, 1973). The recommended rate of application as reflected in the maximum residue limit of 3 mg/kg would not, therefore, necessarily be expected to be effective under tropical conditions; this has been confirmed by Walker and Donegan (1984) who showed synergized pyrethrum to be ineffective and uneconomic under the Malawi conditions, when applied in accordance with the JMPR recommendation.

Table

Maximum residue limits for pesticides in food recommended by the FAO/WHO
Joint Meeting on Pesticide Residues (JMPR) up to 1983
Maximum insecticide residue limits (acceptable daily intake)
mg insecticide per kg commodity, i.e., mg/kg or ppm (mg/kg body weight/day)

	Bioreamethrin	Bromophos	Chlorpyrifos methyl	Deltamethrin	Dichlorvos	Etrimfos	Fenitrothion	Fenvalerate	Lindane	Malathion	Methnerifon	Permethrin	Phenothrin	Phenothrin	Piperonyl butoxide	Pirimiphos methyl	Pyrethrum
Cereal grains	5	10*			2	2*		10*	5	0.5*	8*	10	2	5	20	10*	3*
Barley			5*				10										
Maize				10*			10										
Oats			5*				10										
Rice, in husk			5*							0.5*							
Rice, hulled			5*													2*	
Rice, milled				0.1*			0.1									1*	
Rice, polished				0.1*				1									
Rye			5*														
Sorghum			10*	10*													
Wheat			5*	10*													
Wheat bran, processed								2									
Wheat bran, raw		20*	20*	20*	5		20	20*	5		20*	20	10	15		20*	
Wheat flour, white		2*	0.2*	2*	0.5		2	1*	0.2		2	2	0.5			2*	
Wheat flour, wholemeal			2*		2		10	5*	2		2*	10	2			5*	
Bread, white	0.05	0.5*		0.5*		0.1*		0.2*								0.5*	
Bread wholemeal	0.05	2*		2*		0.5										1*	
Groundnuts, unshelled			2*						0.1			10				50*	
Groundnuts, kernels						2*						1	0.1		8	5*	1*
Groundnut oil																10*	
Nuts			1*						0.2		8*						
Dried beans			1*			2	0.01		0.5	1*		5	0.1				
Dried peas												5					
Lentils																	
Cowpeas		1	1*			2											
Cocoa beans					0.05	5*		0.1*		1*		10					
Dried fish															20		3*
Milk/milk products		0.5*	0.1*			0.02	0.01	0.002	0.01			0.01	0.1			0.05*	
Acceptable daily intake	–	0.04	0.01	0.01	0.01	0.004	0.003	0.001	0.007	0.01	0.02	.0003	0.05	0.2	0.03	0.01	0.04

*Acceptable by Codex Alimentarius Commission as Codex Maximum Residue Limit

Subsequent protection of the fish after it has been properly dried against attack by dermestid beetles has to be on a longer term basis. This means that the fish need to be treated with a contact insecticide with a residual effect of several months rather than several days. At the same time the rate of application of insecticide must not be so high as to cause hazard to the consumer, especially if the fish is eaten fairly soon after drying.

It can be seen from the Table that at present there are no insecticides approved for use on fish by JMPR other than the synergized pyrethrum referred to above. This is not because there are no insecticides which are effective or safe to use, but simply because no submissions have been made to JMPR for their use in this way. Such submissions have to be supported by experimental data and until recently little or no action was being taken to obtain this.

The principal reason for the paucity of data on the protection of fish with insecticides is that this work is normally carried out by the major manufacturing companies which produce and market the particular active ingredients. It is also these companies which normally submit cases for the use of their products for the protection of particular food commodities based on these data. Companies will obviously only undertake this time-consuming and expensive operation if they are convinced that JMPR approval for the use of their products will produce an adequate return in terms of sales to customers. As the potential customer is likely to be a poor fisherman catching and processing his fish in a remote area, it is not surprising that commercial organizations have not been very active in this field.

It would seem therefore, that if the data needed for submission to JMPR are to be generated, it will have to be by research organizations, such as, for example, the Tropical Development and Research Institute, and it is for this reason that TDRI initiated a programme to this end. This programme began with laboratory experiments to determine the most effective insecticides against dermestid beetles (Taylor and Evans, 1982), and fieldwork in Malawi on the protection of fish from blowfly attack during the period 1981-83 using synergized pyrethrum, pirimiphos methyl (actellic) or tetrachlorvinphos (gardona). As is reported elsewhere (Tropical Development and Research Institute, 1984), pirimiphos methyl applied as a dip proved effective in controlling blowfly on drying fish, without causing residues which would constitute a hazard to the consumer. These data have been accepted by the Government of Malawi and are now the basis of an extension programme which has resulted in significant reductions in losses of fish. Further experiments carried out in Malawi during early 1984 to extend the use of pirimiphos methyl as protection from dermestid beetles and to consolidate previous work is described elsewhere (Walker and Golob, 1985).

The programme in Malawi has been supplemented by field experiments in Kenya in 1983 (Walker and Golob, 1985) and in Gambia in 1984 so that the effectiveness of particular systems of protection could be assessed under a range of conditions, so that recommendations made by JMPR will be applicable on as wide an international basis as possible. Experiments in Kenya and the Gambia are concerned with protection of dried fish from attack by dermestid beetles and embrace several insecticides other than pirimiphos methyl, all of which already have JMPR clearance for use on other food. This is important as it confines the scope of the submission to the establishment of "good agricultural practice" in relation to fish treatment. The three insecticides other than pirimiphos methyl which seem to hold most promise as being suitable for the protection of dried fish from attack by dermestid beetles are fenitrothion, permethrin and deltamethrin. Tetrachlorvinphos, which has been tried in Mali, Malawi and elsewhere, would not seem to be an appropriate insecticide to use at present as it has not yet been cleared by JMPR for use on any food.

It is hoped that through the current TDRI programme, one or more of the above-mentioned insecticides will have been cleared for international use for the protection of fish by 1986. This will enable international organizations, such as FAO, to recommend with confidence, the use of particular insecticides and procedures for the reduction of current losses of drying and dried fish by insects, and help to discourage the current indiscriminate use of insecticides (often those which are unsuitable for application to food) for the protection of fish, which seems to have developed in some areas of West and Central Africa.

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PREVENTION DES PERTES DE POISSONS FUMES (TEST D'UTILISATION DU TETRACHLORVINPHOS) AU NIGER

par

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RESUME

Le poisson fumé selon les méthodes traditionnelles est attaqué par les insectes rongeurs (Dermestes et Nécrobia), causant des pertes de l'ordre de 40 % en poids. La méthode de préservation par la chaleur utilisée par les pêcheurs est inefficace et l'utilisation anarchique de produits chimiques hautement toxiques représente un danger pour les consommateurs de poisson fumé. Le test d'utilisation du tétrachlorvinphos pour la préservation du poisson fumé a montré que ce produit assure une protection à 54 % pour une solution à 5 g/l et à 76 % pour une dose double (11 g/l). Il réduit les pertes de poids de 38 % à la dose simple et de 54 % à la dose double. Avec un taux résiduel de 2,5 mg/kg il est possible de vulgariser auprès des pêcheurs l'utilisation de Gardona par pulvérisation, pour la protection du poisson fumé contre l'attaque des insectes.

1. INTRODUCTION

On estime que 60 % des captures totales (2 000 t/an) de l'ensemble du fleuve sont destinées au fumage: soit 1 200 t/an. Les produits fumés sont stockés avant commercialisation. La durée de stockage, pouvant atteindre jusqu'à 6 mois, expose les produits à l'attaque des insectes rongeurs, appartenant à deux espèces de coléoptères (Dermestes et Nécrobia) qui causent des pertes importantes, estimées à 40 % en poids. La prolifération des insectes est plus importante de juin à novembre, période chaude et humide, qui coïncide avec la période de stockage.

En cas d'attaque par les insectes, la réaction du pêcheur consiste à soumettre le poisson fumé à un refumage périodique, entraînant une consommation importante de combustible, une perte de poids et de temps. Cette méthode n'assure pas efficacement la protection du poisson fumé contre l'attaque des insectes. Ainsi, on assiste à l'utilisation anarchique de divers produits chimiques tels que Lindane (Gramelin 20), H C H, Dieldrine et DDT, produits hautement toxiques pour l'homme, et utilisés à même sur le poisson par trempage, aspersion ou épandage. Dans le cadre du Projet de développement des pêches, il s'avère donc impératif de mettre fin dans les plus brefs délais à l'utilisation de produits de haute toxicité et de les remplacer par un autre dont la toxicité pour l'homme est négligeable, par rappor aux produits cités plus haut. Utilisé par les pêcheurs maliens dans le cadre de l'Opération pêche Mopti, au Mali, pour la préservation du poisson séché contre les insectes rongeurs, le tétrachlorvinphos, WP 75, plus connu sous le nom de Gardona et commercialisé par Shell Chimie, se place parmi les insecticides de synthèse les moins toxiques pour l'homme connus à ce jour.

Le test d'utilisation du tétrachlorvinphos, réalisé par le Projet FAO/PNUD/NER/79/018, a pour objet de déterminer les possibilités d'utilisation du Gardona par les pêcheurs pour le traitement du poisson fumé contre les insectes ichthyophages (Dermestes et Nécrobia).

2. MATERIELS ET METHODOLOGIE

Le test porte sur l'étude de deux méthodes d'utilisation: le trempage et l'aspersion du poisson avec deux concentrations différentes de Gardona, ainsi que l'analyse du taux résiduel.

2.1 Protocole expérimental

2.1.1 Test d'efficacité

2.1.1.1 La méthode de trempage

Vingt cinq kilogrammes de poisson frais (lot hétérogène) ont été préparés selon la méthode habituelle des pêcheurs: écaillés, puis répartis en trois lots. Deux lots ont été trempés dans des solutions de Gardona de concentration différente, pendant des durées variables. Le troisième lot non traité a servi de témoin.

Dix kilogrammes de poisson frais ont été plongés dans une solution à 0,05 % de Gardona (5 g dans 10 l d'eau) soit 375 ppm de produit actif, pendant 30 minutes; dix autres ont été immergés dans une solution à 0,10 % (10 g dans 10 l d'eau) soit 750 ppm de produit actif, pendant 15 minutes.

Les lots ont ensuite été egouttés et fumés pendant 15 heures dans un four Altona simplifié. Ensuite ils ont été répartis chacun en 4 lots plus petits dans lesquels un nombre défini de Dermestes a été introduit, puis emballés et fermés avec du papier d'emballage sur lequel le poids, le nombre de poisson, le nombre d'insectes, la dose de traitement, le temps de trempage et la date de stockage étaient mentionnés. Les lots ont été ensuite stockés dans des magasins.

Les observations ont eu lieu après 30 et 90 jours de stockage et ont porté sur:

- le poids
- le nombre de poissons attaqués
- le nombre d'insectes vivants et morts

2.1.1.2 La méthode par aspersion ou pulvérisation

Trente kilogrammes de poisson frais (lot hétérogène) ont été écaillés, éviscérés, lavés puis fumés au four Altona simplifié, et répartis ensuite en deux lots traités plus un témoin non traité.

Cette méthode se différencie de la précédente du fait que le traitement insecticide s'effectue après le fumage.

Chaque lot a été traité par pulvérisation, à l'aide d'une pompe manuelle de type "Flytox" avec des solutions identiques aux précédentes, soit: 0,05 % (5 g dans 10 l d'eau) et 0,10 % (10 g dans 10 l d'eau), ceci représentant respectivement 375 et 750 ppm de produit actif.

Les lots de poisson ont été traités individuellement pendant 30 secondes, puis séchés à l'air pendant 15 minutes avant d'être emballés. Chaque lot a été réparti en 4 paquets dans lesquels un nombre défini de larves de Dermestes a été enseméncé, puis numéroté avec indication du:

- poids du lot
- nombre de poisson
- nombre d'insectes
- dose de traitement
- date de stockage

avant stockage en magasin.

Comme précédemment, les observations ont été faites après 30 et 90 jours de stockage et ont porté sur:

- le poids du lot
- le nombre de poissons attaqués
- le nombre d'insectes vivants et morts

2.1.2 Dosage des teneurs résiduelles

Un échantillon de 5 g traité par la méthode de trempage, et un autre de 5 kg traité par pulvérisation ont été envoyés aux Laboratoires du Tropical Development and Research Institute de Londres au fin d'analyse de taux résiduel.

3. RESULTATS ET COMMENTAIRES

3.1 Méthode de trempage

Les résultats du test d'efficacité de la méthode de trempage ont été un tant soit peu perturbés. Les paramètres observés ne permettent pas une interprétation significative du test.

Seul le nombre de poissons attaqués après un mois de stockage permet de différencier les lots.

Le témoin a été attaqué à 68 %.

Les lots traités à la concentration de 375 ppm ont été attaqués à 55 % et les lots traités à la concentration de 750 ppm à 25 %.

Après 90 jours de stockage, le taux d'attaque était de 100 % pour tous les lots y compris le témoin, le critère de comptage étant la présence de galeries larvaires. Les analyses de taux résiduel confirment les résultats du test d'efficacité.

Taux résiduel: dose simple (375 ppm) donne 1,06 mg/kg de chair de poisson fumé
dose double (750 ppm) donne 1,46 mg/kg de chair de poisson fumé

La protection résiduelle du Gardona par cette méthode et à cette concentration est donc faible, sinon insignifiante.

3.2 Méthode par aspersion

3.2.1 Observations après 30 jours de stockage

(a) Nombre de poissons attaqués

Le critère de comptage étant la présence de galeries larvaires, les résultats furent les suivants:

- lot témoin attaqué à 92 %
- lot à 375 ppm attaqué à 20 %
- lot à 750 ppm attaqué à 5,8 %

(b) Nombre d'insectes vivants

- lot témoin - multiplication des individus; présence d'adultes; mortalité de larves 28 %
- lots traités - pas de multiplication; pas de croissance (375 et 750 ppm) mortalité de larves à 95 % sur dose simple; à 100 % dans le lot à dose double.

(c) Pertes de poids

- lot témoin - 22,68 % de perte
- lot à 375 ppm - 18,63 % de perte
- lot à 750 ppm - 13,80 % de perte

3.2.2 Observations entre le 60ème et 90ème jour.

(a) Attaques: après réensemencement, en progression par rapport au 30ème jour.
Témoin: attaqué à 100 %
- progression 8 %
lot à 375 ppm - attaqué 40 %
- progression 20 %
lot à 750 ppm - attaqué à 23,52 %
- progression 17,64 %

La protection assurée est donc de 53 % pour la dose simple et de 76 % pour la dose double.

(b) Insectes vivants

- Témoin - multitude de larves vivantes
- lots traités - pas de multiplication malgré le réensemencement

(c) Pertes de poids

On considère évidemment que la perte par déshydratation est la même pour tous les lots, ceux-ci se trouvant dans les mêmes conditions de stockage.

- Témoin : 32,40 % - progression 12,57 %
- lot 375 ppm : 20 % - progression 2,75 %
- lot 750 ppm : 14,85 % - progression 1,14 %

Le traitement à dose simple réduit les pertes de poids de 38 % et à dose double, de 54 %.

3.3 Taux résiduels

Les taux résiduels pour les doses de traitement sont:

- 2,5 mg/kg à la simple dose (5 g/10 l d'eau)
- 9 mg/kg à la double dose (10 g/10 l d'eau)

4. CONCLUSIONS

On a dégagé de cette expérience, ce qui suit:

- la protection du poisson par la méthode de trempage est très faible. Il semblerait que la toxicité du tétrachlorvinphos soit très atténuée par la chaleur,
- la protection par pulvérisation s'avère très efficace: 53 % à la dose simple et 76 % à la dose double,
- la réduction des pertes de poids, dues à l'infestation est de 38 % pour la dose simple et de 54 % pour la dose souble.

Ces résultats doivent être considérés avec une certaine réserve, les critères d'appréciation des paramètres observés étant insuffisants. Ils ne tiennent pas compte de la taille, de la teneur en graisse, ni des caractéristiques tissulaires des poissons qui pourraient modifier un tant soit peu les pertes de poids. En tout cas ces résultats confirment une étude précédente sur la préservation du poisson séché.

Le tétrachlorvinphos demeure cependant un produit non homologué sur le plan international, et les connaissances actuelles ne permettent pas d'appréhender parfaitement sa toxicité à long terme après absorption. Néanmoins, selon les critères d'efficacité et le taux résiduel relativement bas, on pourrait l'utiliser pour la prévention des pertes du poisson fumé, par pulvérisation d'une solution à 0,5 g/l.

ANNEXE

Résultats du test de la méthode d'aspersion après fumage

Nº du traitement	Perte de poids (en g)			Taux d'attaque		Taux d'infestation			Période d'observation
	Poids initial	Poids Obser.	% g	Nombre de poissons attaqués	% g	Insect. ensem.	Nombre insect. pour 100 g de poissons	Insectes morts	
Témoin	1 080	835	22,68	11/12	92	28	2,5	8	30 jours
5 g/375 ppm	1 100	895	18,63	3/15	20	21	2,09	20	
10 g/750 ppm	1 010	870	13,8	1/17	5,8	37	3,66	37	
Témoin	1 080	730	32,40	12/12	100	multiplication et croissance			60 à 90 jours
5 g/375 ppm	1 100	870	20,90	6/15	40	21	2,09	18	
10 g/750 ppm	1 010	860	14,85	4/17	23,52	37	3,66	35	

SESSION 4:
MARKETING OF FISH AND FISHERY PRODUCTS/ COMMERCIALISATION DU POISSON ET DES PRODUITS DE LA PECHE

OBSERVATIONS SUR LA MANUTENTION DU POISSON DANS LE PORT DE NADOR

par

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RESUME

Située dans le Nord-Est marocain, la région de Nador a connu depuis ces six dernières années un essor socio-économique important dû à la construction de deux ports distants de 70 km. L'impact de ces réalisations est très positif sur le secteur de la pêche.

La flottille de pêche faible durant les années 1970-80 a connu une augmentation en nombre très sensible et une diversification dans les types d'activité: chalutiers, sardiniers, palangriers. Ces bateaux produisent une trentaine d'espèces de poisson d'importance commerciale notable. Cette diversification attire plusieurs mareyeurs grossistes ou détaillants, locaux ou régionaux. Chaque acheteur s'est spécialisé dans la commercialisation d'une ou de quelques espèces bien définies.

Suivant la valeur et l'importance commerciale du produit, on assiste à des degrés plus ou moins élaborés dans le travail de préparation et le soin apporté pour la conservation ultérieure. Le poisson destiné à l'exportation est trié, emballé puis congelé ou glacé; celui destiné au marché intérieur est gardé dans les caisses d'origine avec ou sans addition de glace.

L'acheminement du poisson est fait de la façon suivante:

- marchés proches (rayon de moins de 20 km), le produit est transporté dans de petits véhicules personnels: voiture de tourisme, camionnettes, etc.;
- pour les habitations dispersées de la campagne et qui sont proches du port ce sont les colporteurs qui font le porte à porte et qui transportent le produit sur des bicyclettes ou à dos d'ânes et de mules;
- pour les souks plus éloignés, le poisson couvert de glace est transporté dans des camions bâchés;
- pour l'exportation, le produit emballé, congelé ou réfrigéré est envoyé à destination dans les camions isothermes ou réfrigérés.

Cette organisation, où se côtoient le moderne et le traditionnel, et qui s'est forgée sur quelques années, permet de mettre le poisson à la disposition des différentes couches de la population, même dans des parties reculées de la région, pour des prix qui sont à la portée de tout le monde.

Les marchés intérieurs, disposés en arc de cercle autour du port de Nador sont également approvisionnés par les mareyeurs qui opèrent dans d'autres ports proches ou lointains: Ras Kebdana, El Hoceima, Larache, Casablanca. Cette concurrence a obligé les acheteurs à se grouper par deux, trois, quatre ou plus. Cette alliance constitue de fait une société sans statut écrit, où chacun respecte le règlement établi verbalement. Les changements d'alliances sont fréquents. Chaque acheteur ou groupe de mareyeurs a des correspondants dans les autres ports et sur les lieux de distribution. Ces représentants ne reçoivent pas de parts sur les bénéfices, mais touchent des commissions, dont le taux est variable, sur la valeur des transactions.

Le littoral méditerranéen du Maroc, dont la longueur est d'environ 500 km, compte actuellement quatre ports de pêches dont deux importants et plusieurs petits centres de débarquement. Le port de El Hoceima, qui était jusqu'en 1982 le principal port de pêche de la région, vient d'être supplanté par celui de Nador situé à 120 km à l'est.

On compte actuellement dans le port de Nador:

- chalutiers	32
- sardiniers	38
- palangriers	37

Le métier de la pêche, pratiqué par des petits bateaux de faible tonnage (<60 TJB) et de faible puissance (200 cv), est de caractère artisanal. Les unités de pêche opèrent dans la frange littorale pendant des durées généralement inférieures à 24 heures. Du fait de cette courte durée, le poisson débarqué est d'une bonne qualité de fraîcheur. Toutefois, les conditions de conservation et de manipulation qui suivront vont être propices à l'altération du produit.

1. MANIPULATION A BORD

Le traitement du poisson à bord se limite aux opérations de triage et de mise en caisse.

Pour les chalutiers, le poisson est trié suivant l'espèce et classé selon la taille. Les caisses sont couvertes par une couche de glace. Quant aux sardiniers qui pêchent les poissons pélagiques de petites tailles tels que la sardine ou le maquereau, destinés à la consommation en frais, la glace n'est pas utilisée systématiquement. Le traitement d'anchois à bord est fonction de sa destination. Celui qui sera envoyé aux usines de conserve est additionné de sel, par contre, l'anchois destiné à la consommation fraîche est conservé dans de la glace.

2. DEBARQUEMENT

Le poisson est débarqué dans les caisses d'origine. La production des chalutiers est transférée dans la criée où elle est exposée à la vente.

La vente des sardiniers se fait par l'exposition d'une caisse échantillon, la totalité de la production est gardée dans le bateau jusqu'au chargement pour sa destination finale.

Le temps qui s'écoule entre la capture du poisson et son débarquement est généralement très court: moins de cinq heures pour le poisson pélagique et moins de 12 heures pour le poisson démersal. Les manipulations que subit le poisson sont réduites ce qui est favorable au maintien de la qualité. Par contre, les conditions de conservations ultérieures sont responsables de la rapidité de la dégradation du poisson.

3. LES MANIPULATIONS A TERRE

La préparation du poisson à terre avant son expédition dépend de l'espèce du poisson et de la destination qui lui est réservée. Toutefois, l'opération principale consiste en un transfert des caisses de la criée aux moyens de transport, avec addition de glace pour les espèces à destination lointaine: souks et marchés des autres villes.

C'est le poulpe qui reçoit la préparation la plus élaborée. Il est vidé, trié, mis dans des cagettes en plastique puis congelé avant d'être exporté dans des camions isothermes.

Le poisson destiné aux marchés locaux n'est travaillé que sur les lieux de vente. L'anchois, utilisé principalement dans les usines de salaisons, est chargé directement des bateaux aux camions qui vont le transporter aux lieux de travail.

Paradoxalement les caisses de poissons pélagiques achetées par les mareyeurs ambulants sont les mieux traitées. Le poisson est trié, additionné de glace, la caisse est couverte de plastique ou de tissus épais.

4. LES CONTRAINTES D'HYGIENE

Il est apparu à partir des descriptions précédentes que le poisson, qui séjourne peu de temps sur le bateau ou sur le quai fait l'objet d'un minimum de manipulations. Si ce peu de manipulations évite la contamination du produit par l'homme, il n'en est pas de même pour le stockage (conditions et environnement).

L'altération du poisson ne provient donc pas du délai écoulé entre la capture et le moment de la vente, mais se développe lors des phases de conditionnement, principalement au niveau de la caisse et du milieu ambiant dans lequel se trouve le produit.

5. LA CAISSE

La caisse dans laquelle le poisson est emballé est faite en planchettes de bois clouées. Elle se prête difficilement au lavage: surface rugueuse, angles rentrants et tranchants, fissures dans le bois, absorption d'eau, dépassement des clous, etc. Ces inconvénients qui existent pour une caisse lavée sont amplifiés dans notre cas, du fait que la caisse n'est pas nettoyée après son utilisation et le long circuit qui la conduit jusqu'aux souks les plus lointains avant de revenir pour être embarquée de nouveau sur les bateaux. Durant ce long périple, la caisse est en contact avec différents agents qui la salissent. En conséquence, la caisse, au lieu de servir de protection au produit, joue le rôle au contraire de vecteur de contamination bactérienne.

L'équipage du bateau ne prend pas soin des caisses. Les traces de dégradation de la qualité n'apparaissent pas à bord. Une bonne qualité, jusqu'au débarquement est donc assurée pour l'équipage. Quant au mareyeur, chez qui le poisson passe le plus de temps, il ne veut pas augmenter ses frais en engageant des ouvriers pour réemballer le poisson. Ainsi, jusqu'à présent, aucun mareyeur ne dispose au port d'un local prévu pour exécuter un tel travail. C'est le détaillant qui essaie d'apporter un minimum de soin à la présentation pour mieux écouler sa marchandise.

Les caisses sont la propriété d'une ou plusieurs personnes qui les donnent en location aux armateurs et aux mareyeurs. Le problème qui se présente est de les collecter à tous les niveaux de distribution pour éviter une perte importante. La responsabilité de l'hygiène des caisses est donc diffuse; aucun utilisateur ne s'y intéresse.

6. LE MILIEU AMBIANT

Si la plupart des espèces destinées à la consommation en frais sont couvertes par la glace, elles ne sont pas, par contre, protégées contre la contamination bactérienne, la poussière, l'écrasement durant le transport, etc.

Pour les espèces de valeur commerciale élevée, le transport se fait dans des camionnettes couvertes ou dans les coffres de voitures particulières qui restent entrebaillés ce qui laisse entrer la poussière. De plus le produit est entassé dans ce coffre. La distance du transport par ces moyens est généralement courte (moins de 20 km) et le tonnage transporté n'atteint pas une tonne par voyage.

Les camions bâchés transportent généralement des quantités importantes sur de longues distances. Les espèces pélagiques: anchois et sardines, constituent une part importante de ces tonnages. Les soins sont minimes: une pelle de glace pour chaque caisse. Dans ce cas l'entassement est important. Du fait que les caisses sont trop pleines, elles se superposent les unes sur les autres en écrasant le poisson et la glace.

D'autres moyens sont également utilisés et nous pouvons citer en particulier:

- les camions isothermes essentiellement pour l'exportation du poisson. Cette méthode représente le maximum de soin apporté;
- les bicyclettes: surtout pour la distribution du poisson dans les quartiers isolés, ou les habitations dispersées;
- les animaux: quelques marchands ambulants commercialisent à dos de mules ou d'ânes, dans les agglomérations d'accès difficile, la sardine, l'anchois ou l'allache. Le nombre de caisses transportées est de une à quatre par détaillant.

En raison du temps de transport assez long et du délai pour l'écoulement de la marchandise, les caisses sont mieux protégées des intempéries du milieu.

Il apparaît d'après cet aperçu qu'il y a une certaine négligence dans le soin apporté à préserver la qualité du produit. Les lois ne manquent pas pour faire respecter cette qualité. Il en est de même pour les services chargés du contrôle. Cette situation est engendrée par les facteurs suivants:

- les soins apportés aux manipulations du transport ne sont pas aussi utiles qu'ils le devraient du fait que précédemment l'exposition de la marchandise n'est déjà entourée d'aucun soin et que la clientèle n'est pas exigeante;
- l'utilisation de moyens sophistiqués alourdissent les charges ce qui se traduit par une augmentation du prix de revient, et par conséquent met le produit hors de la portée d'une partie de la population, fraction déjà pénalisée, d'où des problèmes de malnutrition et de carence protéique d'origine animale qui peuvent en découler.

7. L'ORGANISATION DU MAREYAGE

L'organisation du mareyage dans la région de Nador est adaptée aux conditions socio-économiques et à l'infrastructure existantes.

7.1 L'infrastructure

Le port construit récemment (fin des travaux du port de pêche en 1980) voit l'implantation au fur et à mesure, des infrastructures nécessaires à l'aval du secteur de la pêche.

7.2 La criée

L'Office national des pêches qui est chargé de promouvoir le secteur de la pêche, et a construit une halle aux poissons qui est devenue opérationnelle depuis 1984, fait en outre de son mieux pour organiser administrativement le secteur en amont comme en aval.

7.3 Fabrique de glace

Cette fabrique qui produit de la glace en paillettes a une capacité de 50 tonnes par jour. Si cette quantité couvre tout juste les besoins en hiver, elle est inférieure à la demande durant l'été à cause de l'augmentation du tonnage du poisson débarqué. Cet indice montre clairement l'évolution qui s'est opérée chez les professionnels pour préserver la qualité du produit. Les mareyeurs et les armateurs prennent de plus en plus l'habitude de couvrir le poisson avec de la glace.

7.4 Transport

Si les camions bachés sont les plus utilisés pour le transport de quantités importantes de poisson sur une longue distance, nous constatons ces derniers temps l'introduction de camionnettes légères de 1 à 1,5 tonne de capacité. Ces dernières qui sont utilisées pour le poisson blanc, plus pratiques et conformes aux normes sanitaires, se généralisent de plus en plus ce qui nous laisse optimistes sur l'amélioration de la qualité du poisson à l'avenir.

Il faut noter également que l'arrivée de temps à autre de camions frigorifiques venus d'Espagne pour l'importation du poisson, a motivé les gens de la région, ce qui s'est traduit jusqu'à présent par le dépôt de dossiers de demande d'achat de camions isothermes.

7.5 La profession du mareyage

L'organisation de la profession du mareyage est relativement récente. La criée est fréquentée par les mareyeurs grossistes et détaillants.

7.5.1 Détaillants

La quasi totalité des détaillants qui détiennent des places dans les marchés publics pour la vente du poisson, se procurent directement leur marchandise à la criée. Le poisson acheté de cette façon provient des chalutiers. En effet il est exposé et vendu caisse par caisse. Cette méthode facilite le choix des détaillants et convient à leur type d'achats. Le nombre de détaillants qui fréquente la halle aux poissons de Nador dépasse 100 acheteurs. L'achat de chaque détaillant est de une à quelques dizaines de caisses.

7.5.2 Grossistes

Jusqu'à maintenant, il y a seulement deux grossistes qui achètent le poisson blanc à la criée de Nador. Leurs achats sont destinés essentiellement à l'exportation (poisson noble, crustacé et calamars).

Quant à la production des bateaux sardiniers, elle est vendue à un seul mareyeur qui se charge par la suite d'expédier le poisson sur le marché pour le distribuer aux détaillants. Les acheteurs du poisson pélagique de petite taille travaillent individuellement ou en groupe. La constitution de groupes se fait pour atténuer la concurrence entre les mareyeurs et pour mieux s'entendre sur les prix d'achat. La formation des groupes n'est pas stable et les alliances peuvent changer. Chaque groupe peut être subdivisé en sous groupes de deux à trois personnes.

Deux à trois groupes achètent de l'anchois mais chacun peut s'accorder avec un autre pour commercialiser ensemble de la sardine. Cette alliance qui peut être précaire se constitue généralement durant la saison de la pêche sardinière. En effet l'abondance de la production de la sardine durant l'été, l'exiguïté des débouchés dans la région de Nador, l'absence d'infrastructure de stockage obligent les mareyeurs à s'entendre pour préserver les intérêts.

L'ECOULEMENT DES PRODUITS DE LA MER AU SENEGAL: MAREYAGE, TRANSFORMATION, COMMERCIALISATION

par

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RESUME

Le développement considérable de la pêche artisanale au Sénégal est assez récent; il date d'une trentaine d'années. L'apparition et la croissance des activités de commercialisation proviennent de cette même histoire et des relations qui lient entre elles ces activités à la fois concurrentes et complémentaires. Encore en développement, elles évoluent de façon parallèle et inégale. Les unes profitent des déficiences des autres. Elles n'ont pas de rayon d'action spécifique, qui les conduirait à une relative indépendance.

Une évolution des systèmes d'utilisation des ressources halieutiques ne peut être analysée que globalement à travers les interactions et les spécificités de toutes les activités concurrentes.

Nous ferons une présentation de la genèse de ce système et de sa situation actuelle en montrant les caractères spécifiques des diverses formes de l'utilisation des ressources halieutiques.

Nous axerons la suite de l'exposé sur les problèmes de commercialisation. Une enquête rapide mais récente sur la commercialisation du poisson transformé nous permettra de décrire les différents circuits commerciaux, ainsi que le fonctionnement, les avantages et les difficultés d'un commerce à longue distance.

Toute action dans le secteur des pêches maritimes doit être conçue dans une vision d'ensemble du "système pêche". Les divers éléments de ce système sont interdépendants. Ils rétroagissent entre eux, alors qu'ils relèvent de centres de décisions différents. Ceci rend difficile une gestion globale des pêcheries dont la caractéristique est l'incertitude.

La combinaison d'aspects biologiques et économiques rend nécessaire une approche pluridisciplinaire.

Si les biologistes s'intéressent aux facteurs économiques qui influencent le niveau d'exploitation des stocks et concourent à leur déséquilibre, les économistes oeuvrant dans le secteur de la commercialisation et du développement des marchés doivent être attentifs aux évolutions de la ressource.

Le niveau de la demande et le niveau d'exploitation des stocks se contraignent mutuellement. Des gains de productivité dans la pêche ne sont réalisables que s'il existe des débouchés. Inversement la demande pour les produits de la mer ne se développe pas seule. Des amorces sont nécessaires. La disharmonie potentielle entre l'offre et la demande, existant à un moment par le niveau de développement d'une pêcherie, peut être un facteur de blocage ou au contraire une incitation à un profit mutuel.

"L'exploitation des ressources s'effectue continuellement en situation de déséquilibre et l'hypothèse peut être faite que l'existence même de ce déséquilibre constitue un moteur des transformations dans le secteur de la pêche" (Weber et Meuriot, 1984).

Face à l'instabilité de la production, une priorité doit être donnée aux activités d'écoulement présentant le plus de flexibilité. Elles seules peuvent accommoder les déséquilibres dus à des rythmes d'évolution différents de l'offre et de la demande.

L'EVOLUTION DE LA PECHE ARTISANALE SENEGALAISE ET L'ECOULEMENT DES PRODUITS DE LA MER

Durant toute la période coloniale, les faibles possibilités d'écoulement ont limité la pêche artisanale à un niveau de production assez bas. L'essentiel des débarquements se faisait dans les centres de pêche où existaient des sécheries: entreprises européennes de transformation produisant du poisson salé/séché à destination de la métropole et des pays africains. Ailleurs, le volume des captures se situait au niveau de satisfaction de la demande locale en poisson et en produits venant de l'intérieur, ceux-ci provenant de l'échange de poissons transformés.

Le premier élément décisif pour la pêche artisanale fut l'établissement d'un réseau routier dans les années 1958 et 1960. Le mareyage, auparavant limité à une partie de la desserte ferroviaire, s'est aussitôt développé, suscitant l'augmentation d'activité des centres de pêche désenclavés (Chaboud, 1983).

Le deuxième élément fut la modernisation des techniques de pêche. La motorisation des pirogues, effective à partir de l'instauration d'une détaxe en 1965, l'introduction de filets maillants encerclants et surtout de sennes tournantes en 1973, ont permis d'augmenter considérablement la productivité des pêcheurs. N'ayant jamais bénéficié d'aucune aide de la part des autorités administratives le mareyage ne fut pas à même d'absorber le surplus de captures. Le parc automobile et les dépôts de glace restent insuffisants.

Face aux nouveaux arrivages, la transformation artisanale s'est immédiatement développée sans beaucoup de frais. Valorisant tous les produits débarqués, elle a permis de soutenir l'effort d'investissement fait par les pêcheurs. Sans elle, l'essor donné à la pêche artisanale par l'introduction de nouvelles techniques aurait sans doute été plus difficile. Elle permit d'amorcer un démarrage; pêche, mareyage et transformation artisanale profitèrent ensuite mutuellement les uns des autres.

LA TRANSFORMATION ARTISANALE: UN PIS ALLER?

La gamme des produits transformés artisanalement au Sénégal est variée:

- produits fermentés séchés (guedj, yeet);
- produits légèrement saumurés et séchés (tambadiang);
- produits salés/séchés (sali);
- produits braisés/séchés (ketiakh);
- produits fumés/séchés (metora);
- produits séchés (yosse ou féré féré).

Ces différentes techniques de préparation s'adressent à diverses catégories de poissons:

- espèces non consommées à l'état frais: requins, raies, silures (metora, guedj), cymbium (yeet), poissons pélagiques de très petite taille (yosse);
- poissons altérés, invendus du mareyage (guedj);
- surplus de poissons (guedj);
- poissons pélagiques à l'état frais débarqués en grande quantité: ethmaloses de grande taille (metora), ethmaloses et sardinelles (ketiakh).

Le guedj était anciennement le principal produit transformé. La transformation était le fait des femmes dans le cadre d'une production domestique ou d'une petite production marchande. La commercialisation leur était réservée.

Le metora fut introduit au Sénégal par des Guinéens. Actuellement, ils sont toujours les seuls fabricants de ce produit qui est entièrement exporté vers la Guinée.

L'utilisation des filets maillants encerclants et des sennes tournantes a modifié la structure des captures. Les trois espèces principales capturées au moyen de ces engins: ethmaloses, sardinelles rondes et plates, représentaient 44 % des débarquements totaux en 1982 (CRODT, 1983).

Les stocks de ces poissons pélagiques sont principalement exploités sur la Petite Côte et en 1982 la part de ces trois espèces dans les débarquements était de 74 % à Mbour, 68 % à Joal (CRODT, 1983).

Le mareyage écoule en priorité les espèces de haute valeur commerciale, notamment démersales, capturées en majorité sur la Grande Côte.

La transformation artisanale s'est surtout développée sur la Petite Côte absorbant les captures des filets maillants encerclants et des sennes tournantes. Le ketiakh dont la production était auparavant limitée au Cap-Vert où elle servait à écouler les prises des sennes de plage est devenue sur la Petite Côte le produit dominant. En 1981, la transformation artisanale absorbait près de la moitié des quantités débarquées à Mbour et Joal; le ketiakh représentait 73 % des produits.

La transformation artisanale a atteint une dimension commerciale de grande ampleur. Elle attire de nombreux travailleurs qui font le dynamisme de cette activité.

En 1981, on recensait à Mbour près de 1 200 personnes employées uniquement à la transformation.

De 1978 à 1981, les quantités transformées se sont accrues de 61 %.

Les ressources, du fait de leur mobilité, ne sont disponibles que temporairement. Les pêcheurs suivent les migrations de poissons et, sur la Grande Côte, l'essentiel des débarquements se fait sur quelques mois seulement. Bien que les campagnes de pêche des différents centres soient décalées, l'ensemble des captures au Sénégal présente une assez grande variation saisonnière. L'hivernage correspond à une relative pénurie de poisson. A cette époque, Mbour est le principal centre de débarquement. Indépendamment des variations saisonnières au plan national, l'ensemble des quantités transformées à Mbour et à Joal restent stables sur l'année, à tel point qu'en juillet et août 1978, alors que les captures se trouvaient à leur point le plus bas, la transformation artisanale de Mbour et Joal absorbait la moitié des quantités débarquées au Sénégal (figure 1).

La transformation artisanale ne se limite donc pas à réaliser un ajustement entre le volume des mises à terre et la capacité d'écoulement en frais. C'est une constante active et puissante dans l'utilisation des débarquements. Le mareyage écoule les espèces irrégulièrement capturées. C'est une activité plus variable, très réduite durant l'hivernage.

Lors d'une enquête auprès de 49 mareyeurs, 64 % d'entre eux pratiquaient un autre métier (Chaboud, 1983). Parmi les transformateurs, seuls certains manoeuvres, facilement remplacés, sont des saisonniers.

La transformation artisanale a prouvé son efficacité en prenant une part importante dans l'écoulement des mises à terre au Sénégal. Elle s'est nouvellement développée, et on ne peut la considérer comme un reliquat d'activité ancienne appelé à disparaître.

De faible coût, la transformation artisanale est facile à mettre en oeuvre. Elle attire de nombreux travailleurs. Elle permet d'offrir des protéines à bas prix aux populations de l'intérieur à faible revenu. Le mareyage en frais supporte des coûts de transport très élevés. Des sardinelles achetées en octobre entre FCFA 10 et 30/kg sur les plages sont revendues entre FCFA 300 et 500/kg à Matam sans que les marges ne soient abusives. Selon la capacité du véhicule, la glace représente entre 20 et 50 % du coût de transport (Chaboud, 1983). D'autre part, la desserte des marchés intérieurs comporte de grands risques de pertes.

La transformation artisanale n'est confrontée à aucune contrainte de production minimale ou maximale.

La diversité des techniques de préparation permet de valoriser toutes espèces de poissons, quel que soit leur état de fraîcheur.

On a montré par ailleurs que la transformation artisanale, par ses incidences sur les prix, bénéficie à la fois aux pêcheurs et aux mareyeurs (Durand, 1981).

Mais il est d'autres raisons pour lesquelles la transformation artisanale mérite de la considération.

Les produits de la mer hautement périssables sont débarqués irrégulièrement et massivement. La régulation de leur écoulement nécessite une transformation. La transformation artisanale est particulièrement adaptée au contexte africain.

Les conditions climatiques, handicaps de la conservation en frais, sont mises à profit comme source d'énergie par ce type de transformation.

Les axes routiers intérieurs ne desservent convenablement que les grosses agglomérations. De longue conservation, le poisson transformé n'est soumis à aucun délai de vente, et ne requiert pas de conditions de transport particulières. Il peut être facilement distribué aux populations rurales à faible pouvoir d'achat, carencées en protéines d'origine animale.

Le poisson transformé est très apprécié; il fait partie des habitudes de consommation des populations locales. De nombreux pays d'Afrique en sont très demandeurs.

La transformation artisanale semble être au Sénégal le mode d'écoulement approprié pour les petits pélagiques côtiers capturés localement par la pêche artisanale. Les entreprises de transformation industrielle (congélation, farine, conserverie) seraient l'autre débouché possible pour ces espèces. Mais ces ressources instables subissent de fortes fluctuations d'abondance. Avec une capacité de traitement fixe, les usines doivent faire face à des variations saisonnières régulières et à des variations d'abondance à plus long terme. Ceci occasionne des surdimensionnements temporaires difficiles à gérer et très couteux en fonctionnement. La transformation artisanale non confrontée à ces coûts peut offrir aux pêcheurs des prix beaucoup plus rémunérateurs.

La faillite de l'usine de farine de poisson de Djifère est exemplaire à cet égard.

Cette région disposait d'un important stock de poissons pélagiques. L'implantation d'une usine permit l'exploitation de ce stock, irréalisable autrement en raison de l'éloignement des marchés.

Les pêcheurs furent incités à augmenter leur productivité qui atteignit celle des bateaux de pêche industrielle. Mais les pirogues sénégalaises sont très limitées dans leur rayon d'action, et le stock de poisson fut vite surexploité localement (Fréon-Weber, 1982). Les bas prix proposés par l'usine et la baisse des rendements diminuèrent vite les apports à l'usine qui ne disposait d'aucune autre source d'approvisionnement. Seul débouché également pour les pêcheurs locaux, l'usine se trouvait sous-dimensionnée lors des périodes de fortes prises. Sept pour cent des apports, soit 1 300 tonnes de poissons, durent ainsi être rejetées en mer en 1979 (Fréon et Weber, 1962).

UNE INCONNUE: LA COMMERCIALISATION DES POISSONS TRANSFORMES

La transformation artisanale est une activité autonome qui jusqu'à présent a peu attiré l'attention des autorités.

Cependant il semblerait que les changements qui l'ont marquée se soient peu répercutés sur la commercialisation de ces produits.

L'examen des enquêtes de consommation alimentaire effectuées par l'ORANA montre que le poisson transformé pénètre mal les régions de l'intérieur (tableau 1).

Traditionnellement, seules les femmes et les agriculteurs venant vendre leurs productions s'occupaient du commerce du poisson. Les hommes ont investi le mareyage en frais, mais les non-agriculteurs sont encore peu nombreux à s'intéresser au commerce du poisson transformé.

Les femmes commercialisent sur de petites distances et font la vente au détail.

Les agriculteurs, en dehors de la saison de culture, se chargent d'approvisionner leur région en poissons transformés. Certains finissent par se consacrer entièrement à ce commerce.

Les nouveaux venus dans cette activité sont des hommes jeunes, parfois diplômés, à la recherche d'un emploi. Ils sont attirés par les perspectives de profit que laisse espérer la déficience des commerçants. Ils commercialisent de grosses quantités dans les zones plus éloignées.

La méconnaissance des marchés, l'ignorance de l'accueil qui peut être fait à ces produits en font une activité risquée. Ils font figure d'aventuriers, de pionners, et certains, au début, essuient de grosses pertes (Faussey, 1984).

Enfin la renommée grandissante de Mbour, gros centre de production, attire de nombreux étrangers maliens, guinéens, togolais, etc., qui se consacrent à l'exportation.

Ces commerçants travaillent rarement seuls. Ils s'associent parfois à des transporteurs et disposent en général de commissionnaires locaux. La marchandise circule entre grossistes, semi-grossistes et détaillants. La multiplication des agents le long de la filière réduit pour chacun l'incertitude et donc les risques, elle permet le partage des moyens mis en oeuvre, actuellement très limités.

Les circuits de commercialisation sont mal connus. Les demandes régionales liées aux habitudes alimentaires sont spécifiques de certains produits. Le ketiakh est commercialisé dans les régions de Thies, Djourbel, du Cap-Vert et du Siné Saloum. Le tambadiang est distribué dans la région de Louga, du Fleuve et du Sénégal oriental (Faussey, 1984).

Les produits transformés sont encore très mal diffusés dans les régions éloignées. Le développement de la production a eu pour conséquence l'augmentation de la consommation de poissons transformés dans le bassin arachidier où ces produits étaient déjà connus.

Destiné par sa nature à un circuit de commercialisation assez long incluant des échanges inter-africains, le poisson transformé dispose d'un vaste marché loin d'être couvert. Il est anormal que le Sénégal, premier producteur de poisson de l'Afrique de l'Ouest, soit importateur de poissons transformés. "En 1972, le Sénégal est devenu le troisième client du Mali, surclassant la Haute Volta et la Guinée, avec 224 tonnes de poissons fumés séchés" (Sow, 1975).

L'exportation de poissons transformés est peu habituelle aux commerçants sénégalais. Elle reste réservée aux étrangers rodés à l'échange international de ces produits.

Aucun commerçant de poissons transformés ne dispose encore de véhicule propre. Tous utilisent les transports en commun. Certains commencent à s'associer pour louer des véhicules. Si Mbour est devenu le premier centre producteur, c'est certainement par l'importance du trafic de sa gare routière. Le Siné Saloum dispose d'importants stocks de poissons pélagiques. La transformation artisanale n'a pu s'y développer en raison de son enclavement. Les commerçants sans l'assurance de trouver de la marchandise ne se risquent pas à visiter cette région mal desservie par les transports.

Le développement de la transformation artisanale dans cette région ne peut se faire que par l'établissement de contrats de production spécifiant le rythme de livraison entre transformateurs et commerçants ou par une organisation coopérative des producteurs permettant l'achat de camions pour l'écoulement sûr et régulier des produits.

Non périssable, le poisson transformé est parfaitement adapté à une distribution dans les zones rurales.

Le marché intérieur sénégalais est encore loin d'être saturé en matière de consommation de poissons transformés. L'importance de ces produits pour l'alimentation humaine mérite l'engagement d'une action pour assurer son développement (financement de camions, établissement de dépôts).

Dans tous les discours, la pêche est le "pétrole bleu" du Sénégal. Sa finalité doit être le rééquilibrage de la balance commerciale et des efforts sont engagés vers les activités exportatrices.

Ces entreprises coûteuses d'exploitation offrent de bas prix aux pêcheurs. La valorisation est essentiellement réalisée à la fin de la filière par le pays importateur (Aubertin, 1982). Leur rapport en devises devrait être mesuré à la valeur ajoutée apportée par la transformation artisanale où le nombre d'emplois est considérable.

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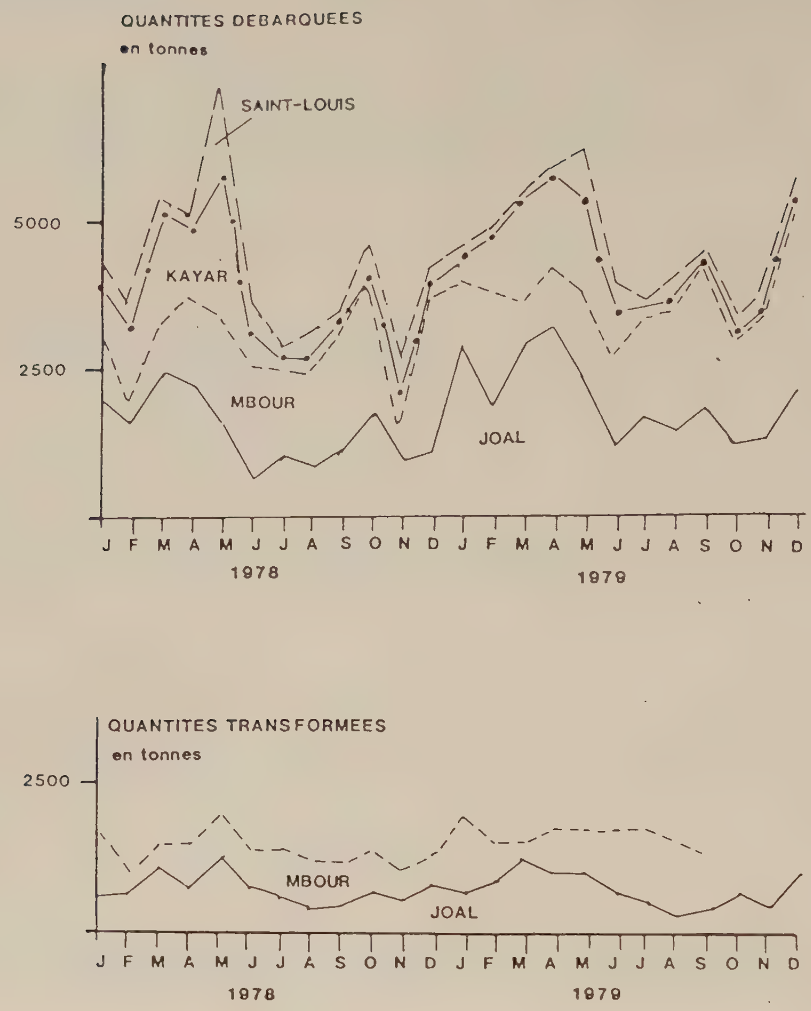

Figure 1 Evolution mensuelle en 1978 et 1979 des quantités débarquées à Saint-Louis, Kayar, Mbour, Joal, et les quantités transformées à Mbour et Joal (en tonnes de poissons frais)

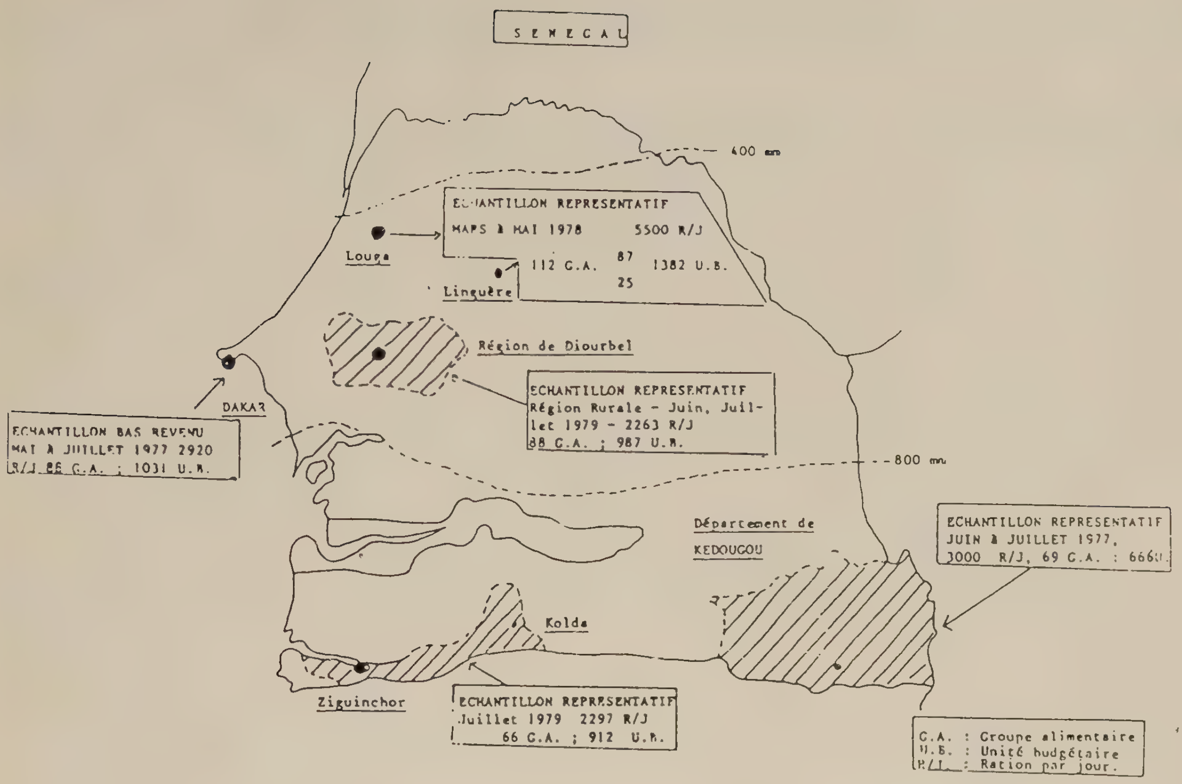
SENEGAL
400 mm
ECHANTILLON REPRESENTATIF
MARS À MAI 1978 5500 R/J
112 G.A. 87/25 1382 U.B.
Louga
Linguère
Région de Diourbel
ECHANTILLON REPRESENTATIF
Région Rurale - Juin, Juillet 1979 - 2263 R/J
88 G.A. ; 987 U.B.
DAKAR
ECHANTILLON BAS REVENU
MAI À JUILLET 1977 2920
R/J 86 G.A. ; 1031 U.B.
800 mm
Département de KEDOUGOU
ECHANTILLON REPRESENTATIF
JUIN À JUILLET 1977,
3000 R/J, 69 G.A. : 666U.
Kolda
Ziguinchor
ECHANTILLON REPRESENTATIF
Juillet 1979 2297 R/J
66 G.A. ; 912 U.B.
G.A. : Groupe alimentaire
U.B. : Unité budgétaire
R/J : Ration par jour.

Tableau 1

Consommation de poisson frais et de poisson transformé par personne et par jour dans cinq régions du Sénégal (4 978 personnes)

Régions	Total poisson g	Poisson frais g	Poisson sec g	Apport protéique g	% total protéines	Apport protéique g	% total protéines
Dakar	1 472	1 381	91	149	29,2	28	5,5
Louga	1 040	936	104	99	20	38	7,7
Linguere	538	443	95	48	10,9	34	7,7
Kedougou	22	16	6	2	0,3	3	0,5
Casamance	666	627	39	62	11,7	18	3,5
Diourbel	139	38	101	8	1,2	60	9,5

Source: enquêtes de consommation alimentaire 1977-79 - ORANA

FISH HANDLING AND MARKETING IN THE KIGOMA REGION OF LAKE TANGANYIKA - UNITED REPUBLIC OF TANZANIA

by

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ABSTRACT

The paper describes the present handling and marketing practices in the Kigoma region of Lake Tanganyika in Tanzania. The shortcomings and deficiencies which exist within the fresh and processed fish handling and marketing are discussed. General recommendations for reorganization of the marketing system to make it more efficient are given. A brief outline of the development objectives of the FAO-assisted small-scale fisheries development project is also provided.

1. INTRODUCTION

1.1 Scope of the Report

The purpose of this paper is fourfold:

(a) to describe the present fish handling and marketing practices in the Kigoma region,

(b) to delineate and analyse the shortcomings and deficiencies which exist within the fresh fish and processed fish handling and marketing sectors,

(c) to give a brief outline of the development objectives of the FAO-assisted small-scale fisheries development project and to describe the contributions it is attempting to make in the area of fish handling and marketing, and

(d) to provide a set of general recommendations on how the fish marketing sector in Kigoma as a whole could be restructured and reorganized to overcome some of its present deficiencies.

It should be noted, however, that because of time and work constraints imposed on the writer, the paper is not the result of a thorough and detailed fish production and marketing survey in villages over a sufficiently long period of time, but rather the outcome of general observations and various discussions held with village leaders and fishermen over the past three months.

The following comments should therefore be read and assessed more along the lines of a strategy paper upon which further detailed surveys and feasibility studies could be based if so desired.

2. GENERAL PRODUCTION TRENDS AND THEIR EFFECTS ON THE FISHING INDUSTRY

Production trends recorded for the Tanzanian side of the lake over the past ten years have shown a significant degree of fluctuation in annual yield from a high of 76 000 t in 1974 to a low of 38 000 t in 1980[1]. This can partly be explained by the fact that a sizeable proportion of the fishery is based on the small, rapidly growing but short-lived freshwater sardines (Stolothrissa tanganicae and Limnothrissa miodon), also called dagaa and lumbo respectively in the local terminology. Biological oscillations are typical for these species.

Another contributing factor is the general decline in the quality of gear used by the fisheries sector. This has largely been caused by a gradual deterioration in general economic conditions over the past decade and a resulting shortage of foreign exchange in particular. Since 1979/80 gear and spare parts of various sorts have become more and more scarce and difficult to obtain[2].

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[1] See Annex 1, Table 1

[2] Among others, this has led to a gradually increasing downtime of fishing vessels: whereas previously the semi-commercial sector was operating for about 270 days per year, this figure has now been reduced to 200 days per year

This factor, combined with the biological fluctuations of the resources, has led to the conclusion that present catches from the waters bordering the Kigoma region of the Lake are likely to be in the vicinity of about 25 000 t per year.

The decline in overall production has been accompanied by a decrease in the catch per unit effort (cpue). It must be concluded that despite rising consumer prices for fish, the net returns to the rural based fishing communities have not been able to keep pace with the general level of inflation.

It is estimated that at present there are between 5 000 and 8 000 fishermen engaged in fishing operations in the 21 major fishing communities along the Lake shore, as compared to 10 200 and 10 700 recorded for 1976 and 1980, respectively[1/]. Most of these fishermen are engaged in fishing on a part-time, seasonal basis, and are otherwise involved in agricultural production. Only 30 percent of the total number of fishermen are believed to use fishing as a full-time occupation.

Judging from the number of registered, but unused fishing boats and canoes scattered along the Lake shore, it would appear that the developments over the past five to six years in particular have led to a gradually increasing under-utilization of capital assets and that marginal producers are leaving the industry.

3. THE SOURCE AND THE MAIN FISHING METHODS USED

The fisheries resource can be separated into two parts: the pelagic and demersal fisheries. The former is estimated to contribute about 80 percent of the total annual production, whereas the demersal sector is estimated to account for only 20 percent, which would amount to some 5 000 t per year at present production levels.

The category of pelagic fish comprises the following six species:

(a) two clupeids (Limnothrissa miodon, or lumbo in local terminology, and Stolothrissa tanganicae, or dagaa), and

(b) four predators (Lates mariae, or sangala; L. microlepis, or nouzi; L. angustifrons, or gomba; and Luciolates stappersii, or mikebuka).

Within the group of pelagic species the catches of Lates and Luciolates are estimated to amount to 10 percent and 40 percent, respectively. Clupeids species are believed to account for the half, which would amount to some 10 000 t per year.

The pelagic fishery in the Kigoma region is entirely a night fishery and its intensity varies with the lunar periods during a given month. The most productive fishing areas are between 2 and 4 miles offshore.

The main fishing methods presently employed in the pelagic sector are lift-netting, lusenga/scoop-netting and purse seining. Whereas the former two methods are exclusively village based and concentrated inside a limit of 1-2 miles offshore, the purse seine fishery is only operated within a radius of 10 miles out of Kigoma town at present.

The lift-net fishery uses catamaran or trimaran wooden boats each about 7 m in length. The net size varies between 10-12 m and 15-17 m in diameter and 15-20 m in depth depending on the number of boats used. The main means of propulsion are by paddles. Outboard engines are only occasionally used, and then mainly in villages nearby Kigoma. Up to 4-6 kerosene pressure lamps per fishing unit are used for fish attraction.

The lusenga/scoopnet fishery uses a single hull canoe or small wooden boat of up to 4-5 m in length. It is exclusively powered by paddles and usually equipped with 2 kerosene pressure lamps.

The Kigoma based purse seine fishery presently comprises three fishing vessels consisting of one of commercial size (LOA 16-18 m; net size: 340 m x 110 m deep), one of semicommercial size (LOA 14-15 m; net size: 250 m x 80 m deep) and one artisanal type/training ring-netter vessel (LOA 11.5 m; net size: 150 m x 50 m deep). Each of these vessels is equipped with one net boat and up to 5 light boats using 4 kerosene pressure lamps each.

In contrast, the demersal fishery sector is entirely artisanal and village based using hook and line, beach seining and gillnetting as its main fishing methods[2/].

[1/] Source: Fisheries Annual Reports - Kigoma

[2/] The main species caught are given in Annex 1, Table 2

It would appear that this type of fishery is much more common in villages south of Kigoma, particularly in those which are situated in the vicinity of some of the many muddy and turbid river systems which are feeding the Lake, e.g., the Malagarasi, Rufulu and Ifume Rivers.

This conclusion is supported by the fact that the area of inshore belt within the established isobath lines of 0-50 m and 50-200 m, respectively, is only insignificantly small along the Lake shores north of Kigoma. On the other hand, the area of inshore belt between 0-50 m alone is estimated to amount to some 1.625 km^2 between 5° S (Kigoma/Ujiji) and 7° 30'S (around Kipili/Rukwa region)1/.

4. SUMMARY OF 1984 FISH PRODUCTION ESTIMATES BY SECTOR AND GROUP OF SPECIES (TONS)

Small-Scale Fisheries Sector		Semicommercial Sector	
(a) Pelagic Fishery		(b) Pelagic Fishery	
- Clupeids	10 000	- Clupeids	90
- Predators	10 000	- Predators	210
(b) Demersal Fishery			
- table fish and haplochromis	5 000		
Total	25 000	Total	300

The artisanal, village based fishery is by far the largest sector contributing almost the entire portion of the total estimated annual production of slightly more than 25 000 t.

In contrast to the Kigoma based semicommercial fishery, by far the largest section of the small-scale fisheries sector can only be reached by sea and has no direct links, either by road or railways with the interior Tanzanian markets2/.

These geographical differences determine the existence of two principally different fish handling and marketing systems in the Kigoma region.

5. THE FRESH FISH HANDLING AND MARKETING SECTOR

Fish landings at selected beaches within the Kigoma town area (Kibirizi, Shed Beach, Bangwe and Ujiji) as well as in neighbouring villages further south of Kigoma (up to Ilagala) usually take place during the morning hours when the fishing units return from their night's fishing. They are met by a small number of wholesale buyers and/or fishmongers/retailers (depending on the type of fishery).

At Shed Beach, the landing site for the Kigoma-based purse seiners, there are usually three different groups of wholesalers. Each of these groups appears to specialize in buying from either one of the fishing units and normally pruchases the vessel's whole catch. In cases where the three purse seiners' combined landings are low to moderate, smaller portions of the catch are sold off consecutively directly by the wholesalers to the retail fishmongers.

If combined landings are high, around 3.0 t and above, the major part of the vessel's catch is marketed by the buying trader himself using small trucks (1.0-2.5 t capacity).

A proper auctioning system at the level between boat owner or operator and wholesaler does not exist at present and ex-vessel prices are arrived at purely through negotiations. Due to the customary relationship between boat-skipper and wholesale buyer, sales of fish directly to retailers occur only seldom. Traders are known to develop close ties with individual fishing units who, from time to time, even permit them to take fish on credit. This practice is quite common to both for the semi-commercial and artisanal fresh fish marketing sector.

1/ See "Experimental Beach Seine Fishing on Lake Tanganyika", by E.D. Andrianos, FAO, Rome, 1979 p. 2-3

2/ See Annex 1, Map 1: this holds true for all major fishing communities with the exception of those situated in the immediate vicinity of Kigoma, such as Kibirizi, Bangwe, Ujiji, Kaseka, Mwakisega and Ilajala

Neither of the fishing units presently operating in the Kigoma region is selling fish by weight. The selling units for the purse seiners are wooden boxes each holding an estimated 25-27 kg of fresh fish (depending on the species). The catch is normally sorted on board the vessel prior to arrival at the landing site. Catches of Luciolates stappersi (or mikebuka) are only graded into juvenile and fully-grown sized ones in case of low to moderate quantities. The selling units for the artisanal fisheries sector are bamboo baskets (or kitebos) capable of holding between 60 and 90 kg of fresh fish.

Shed Beach is also the main landing site from which big sized fish (sangala, etc.) is transported to Kigoma town and its suburbs. These big sized species are sold on a piece by piece basis.

All fresh fish in Kigoma is presently handled and marketed without prior gilling or gutting.

Data for Shed Beach over the past two years indicate that there are significant fluctuations in the volume and species composition of fish landed, both on a daily and on a monthly basis. Peak landings are normally recorded during the rainy seasons which last from about the middle of October to the middle of December, and the middle of February to the middle of May, respectively. During these two seasons the proportion of clupeids in the overall catches is generally higher than in the dry periods. To give an example, combined production for the three purse-seine units can vary between 300-400 kg and up to 15 t on a day-by-day basis, resulting in equally extreme fluctuations in ex-vessel prices to boat owners.

This is mainly due to the fact that ice, small chiller or freezer facilities are presently not available for temporary storage. The fresh fish market is basically a one-day-off wet fish market, and prices are therefore very sensitive to daily fluctuations in supply. In addition, poor communication and transportation also contribute to fluctuations in prices: at the moment, information on volume and ex-vessel prices from various other fresh fish landing sites within the Kigoma town area pass around very slowly; this makes it difficult for the trader and fishermen to be fully aware of the overall price and supply. Furthermore, lack of adequate transport facilities hinders movements of fresh fish from beaches with consequent excess supply there.

When combining the semicommercial and part of the artisanal fishery, the average supply of fresh fish to Kigoma is considered to be in the range of 2.5-3.0 t per day at present.

Kigoma Town Area - 1984/85 Retail Price Estimates

Species	Overall high supply of pelagic fresh fish (>2.5-3.0 t/day)	Overall low to moderate supply of pelagic fresh fish (<2.5 t/day)
Pelagic:		
Clupeids	1 x heap at 400-500 g = T Sh 5.00	1 x heap at 400-500 g = T Sh 10.00
Luciolates:		
- juveniles	8 x pieces at 150-200 g each = T Sh 50.00	12 x pieces at 150-200 g each = T Sh 50.00
- fully grown sized ones	3 x pieces at 250-300 g each = T Sh 50.00	5 x pieces at 250-300 g each = T Sh 50.00

Demersal fish is mainly sold in the Ujiji markets. Unlike pelagic species, prices for demersal fish do not appear to fluctuate in accordance with variations of supply. Market prices seem to be relatively stable and more dependent on consumer preferences for certain types of species.

It is worthwhile mentioning that the amount of T Sh 50.00 to some extent represents the upper limit of consumer expenditure for fish. What varies is the number of pieces of fish which can be obtained for this given amount of money.

In comparison, the present price structure for other animal protein products is as follows:

Cow meat	T Sh 50.00/kg (regulated price)
Goat meat	T Sh 60.00/kg (regulated price)
Poultry	T Sh 110-140/kg (free market price)

Note: T Sh = Tanzanian shilling

Fish retailing in the Kigoma town area is generally conducted from little makeshift stalls in general market places or from open concrete slabs in the main public market buildings.

The principle modes of transporting fish are by headloads, bicycles and small hired or owned trucks.

With a resident population of about 40 000 the daily fish protein requirements in Kigoma town and its suburbs are believed to be around 5 t. However, actual market demand appears to be falling short of these nutritional requirements, a fact which can partly be explained by the recent decline in real purchasing power for the lower income groups of the population.

When total landings exceed about 3.0 t of fresh fish per day, the prices wholesalers are prepared to offer drop significantly and excess supplies of fish have to be transported to outside villages and Kasulu town markets. Villages which receive fresh fish from Kigoma include Bitale, Kidawe, Mahembe, Zeze and Kabanga[1].

The significant drop in wholesale prices finds its explanation in the very high marketing costs when vehicles have to be used: the generally bad roads outside Kigoma result in high vehicle repair costs; other direct operating expenses are also inflated because of limited fuel supplies and the difficulty in obtaining spare parts for maintenance and repair.

Prices for fresh dagaa are comparatively less sensitive to changes in overall supply, provided, however, weather conditions are favourable for sundrying. During the rainy season even relatively moderate landings are difficult to dispose of. The proportion of dagaa sold for immediate consumption is small.

As far as demand in Kigoma town and its suburbs are concerned there appears to be a clear preference for fresh fish over processed fish products. In addition, within each category it is the bigger-sized species which are generally more sought after. Consumption of bigger-sized fish is however, confined to a relatively small group of people who are able and willing to spend between T Sh 100.00 and T Sh 180.00 at one time (depending on supply).

On the other hand, dagaa and other small pelagics are generally more readily available and the size of the selling units (heaps) can be made to accommodate any amount of money the consumer wishes to spend.

Fish is generally not stocked or stored at home and purchases are usually prepared for immediate consumption the same day.

The fish purchase and consumption frequency of a given household per month is a direct function of its distance from the supply centre, and decreases in those interior villages and towns which are further away from Kigoma. Retail fish marketing in the villages usually takes place in open air grounds with or without raised wooden racks, on which the items for sales are displayed.

The shortcomings and deficiencies in the present fresh fish handling and marketing system in Kigoma can be summarized as follows:

(a) because of the fact that the market is almost exclusively supplied by the pelagic fisheries sector, fresh fish is only available in Kigoma and other nearby areas over a period of 20-22 days per month (during the moonless periods);

(b) fluctuations in the daily supply of fish and the absence of any suitable fish storage facilities make it very difficult for both producers and consumers to plan ahead their incomes and expenditures;

(c) the absence of a proper fish auctioning system at the wholesale stage is considered to constitute an undue degree of discrimination against the fish producer;

(d) because of its limited area, its location, its steepness and unevenness the Shed Beach is not considered the most suitable landing site for the semicommercial fishery;

(e) as each of the three companies or institutions engaged in the purse-seine fishery is operating rather independently from the other ones, overall fish production and marketing costs are believed to be excessive and beyond the limit of a more rational utilization of resources. The best example is that every company or institution is presently operating its vessel on drum fuel (supplied by the Regional Administration) rather than attempting to join forces and obtain a much cheaper bulk fuel supply for the whole of the semicommercial sector (to be supplied directly from Dar-es-Salaam). The same conclusion holds true for certain aspects of the fish transportation and marketing sector as well as for the purchasing of replacement netting materials and other items;

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[1] See Annex 1, Map 1

(f) when transporting large quantities of fresh fish by truck the product is not boxed, which results in a certain amount of the product being unnecessarily squashed.

6. THE PROCESSED FISH HANDLING AND MARKETING SECTOR

Because of the mountainous landscape bordering most of the Lake shores, about 16 out of the 21 major village production centres in the Kigoma region are rather isolated and do not have direct access to the interior markets. Apart from a number of foot-paths along the hills they can only be reached by sea. Thus, geography has an overriding influence on the fish handling and marketing practices being applied in the small-scale village fishery sector.

Although more detailed quantitative estimates are not to hand, it can be concluded that most big fish (bigger pelagics and demersal species) is either used directly for home consumption in the villages themselves or is sold in fresh form to nearby villages easily accessible through village foot-paths by small-scale fish traders using overhead baskets. Part of this marketing system also takes the form of a barter trade in villages that do not have access to sufficient farming land to grow vegetables and other type of foodstuff.

Where landings of big sized fish are in excess of fresh fish requirements, the fish is smoked.

6.1 Smoking Technique for Big Fish

Luciolates stappersii, or mikebuka in local terminology, is the species most commonly used for smoking. There are several reasons: first of all, it is a medium-sized species of up to 30-35 cm in length and a maximum body width of 8-10 cm. Mikebuka is therefore more suitable for smoking than bigger sized Lates and other fish belonging to the Haplochromis family. Secondly, it has the advantage of being rather uniform in size, a fact which greatly facilitates shift smoking.

The smoking process itself takes place just above an earth hole of about 1.5 m x 1.5 m in diameter and about 1.0 m in depth. Thick branches of firewood are placed inside the hole and set alight. The fish is usually smoked whole with neither the gills nor intestines removed beforehand.

The tail fin of the fish is slid through the gills thereby almost forming a circle; the bent fish is then placed one by one on a wooden stick which in turn is put across the earth hole.

A maximum of about 70-100 fish, i.e., 6-7 wooden sticks placed parallel to each other and holding 12-15 fish each, are smoked in this way in one shift.

Depending on the smoking time and the type of wood being used, the shelf life of smoked mikebuka is estimated to be about 3 to 4 weeks during the dry season and 2 to 3 weeks during the wet season.

Another factor greatly affecting the quality of the final product is the quantity of firewood used. It would appear that not all the lakeshore villages in the Kigoma region have sufficient quantities of firewood, and that there are obvious natural limitations as to how far the smoking of fish could be further expanded.

The shortcomings and deficiencies inherent in this type of smoking method are as follows:

(a) the quality of the final product is considered to be of a relatively low standard because in some villages not enough firewood is available; this results in:

  (i) the inefficient use of available firewood resources: a significant amount of heat and smoke dissipates from the earth hole without even touching or passing the fish,

  (ii) generally too short a time for the fish to be properly smoked,

(b) quality is poor because the fish are not gilled, gutted or otherwise prepared beforehand;

(c) the rather short shelf life of the product combined with the unfrequent and very irregular visits of only a few fish traders by boat has the effect that the artisanal fishing community is presently not in a position to derive the maximum possible benefits from this type of processing both in terms of economic returns and market penetration outside Kigoma.

6.2 Drying Techniques for Dagaa

By far the most important source of cash income for small-scale fisheries along the Lake shores is catching and processing of Stolothrissa tanganicae or dagaa in local terminology.

This can mainly be explained by the fact that the processing of dagaa through sundrying is comparatively much easier than the smoking of bigger fish. Furthermore, the shelf life of the final product is also much longer, thereby allowing wider market penetration and resulting in higher returns to the villages. Regional trade in dried dagaa extends as far as Dar es-Salaam to the East, but also penetrates other neighbouring countries such as Zaire, Burundi and Zambia. Exports to neighbouring countries - which can also take the form of barter trading - are thought to be particularly frequent from fishing communities which are located close to the border with either Burundi (in the North) or the Rukwa region (in the South), where the distances to Zambia and Zaire are certainly shorter than to the regional centre, Kigoma.

Compared with the quantities of processed fish consigned by railway to other parts of the country, shipments leaving Kigoma by road are thought to be much smaller.

The sundrying of dagaa is done in the villages by spreading the whole fish[1] on the adjacent lake beaches. During the drying process, which depending on the prevailing weather conditions and the intensity of the sunlight takes a minimum of 1 1/2-2 days, the product is regularly turned over using bamboo rags.

The shelflife of the product normally varies between 1 1/2-2 months.

Unfortunately, the peak fishing period for dagaa falls in the two rainy seasons starting from aroung middle of October. This naturally has an adverse effect on the efficiency of the drying process: the fish has to be frequently removed from the beaches and the drying process interrupted because of impending rain showers. Furthermore, the moisture content of the beach sand is significantly higher during the wet season, thereby slowing drying.

As far as the marketing of dried dagaa is concerned, there are three different product grades, i.e., first grade, medium grade and below-medium grade. The present prices[2] for these various types of product are:

	Dry Season	Rainy Season
First quality grade:	T Sh 3 000-3 500/bag[3]	T Sh 1 000-1 500/bag
Medium quality grade:	T Sh 900-1 200/bag	T Sh 500-700/bag
Below-medium quality grade:	T Sh 500-800/bag	T Sh 300-400/bag

In view of the seasonality in catches and prevailing weather conditions, the largest portion of sales undertaken by the villages over the dry weather season would fall in the first category, whereas the bulk of the production during the remainder of the year would come under the medium to below-medium quality category.

For dried dagaa two main trade factors generally seem to work to the disadvantage of the small-scale fishing communities:

(a) only a minority of the villages have adequate simple, relatively durable and protected facilities for the storage of dried dagaa. Most of them are therefore not in a position to play the market to any extent, but instead are forced to dispose of the product at the first opportunity;

(b) at the village wholesale buying level, the dagaa trade appears to be dominated by only a few travelling merchants. Most of them are believed to be acting as agents for wholesale dagaa traders based in Ujiji. These visiting agents only come very irregularly and infrequently to the fishing communities, a fact which constitutes a further disadvantage to the small-scale producers. Furthermore, it would appear that none of the village councils has a clear perception of the quite considerable margins prevailing at the moment between FOB village wholesale and Dar es -Salaam wholesale and retail prices, for example. This, together with the above-mentioned constraints,places the villages in a very difficult bargaining position at the moment.

The sundried dagaa brought to the Ujiji wholesale collection point is mainly collected from fishing villages along the lake south of Kigoma town. The dagaa is carried in "water taxis" which are the main means of transportation around the Lake. Dried dagaa from villages north of Kigoma is normally offloaded at Kibirizi beach where it is either sold immediately to waiting traders for forwarding by railway to other regions to the East or transported by truck or water taxis to Ujiji market.

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[1] Before sundrying, the fish is not prepared in any way

[2] FOB village prices, paid by the fish trader or agents

[3] Weighing between 55-60 kg on an average, bags made out of jute

The market transactions at Ujiji appear to be dominated by only a few wholesale buyers. Occasionally, the National Milling Corporation (for lower grades of dagaa) as well as visiting traders from Tabora, Mwanza and other regional market centres take part in trading operations. As with the semicommercial fresh fish landings, the dried product loaded by the agents is not disposed of through an auction process but purely through negotiations with individual, prospective buyers.

The main shortcomings and deficiencies in the handling, processing and marketing system for dried dagaa are considered to be as follows:

(a) the quality of the final product is adversely affected because sundrying is done on the beach sand, whose moisture content is particularly high during the wet season; the recovery rate for this type of processing method ranges between 20-23 percent as particles of sand and small stones get stuck to the product;

(b) the estimated average shelflife of 1 1/2-2 months is inadequate;

(c) the overall proportion of sales going to the National Milling Corporation for further processing into animal feed stuff appears to be unnecessarily high, constituting a considerable degree of product and economic loss both to the consumer and village producers;

(d) the economic returns to the villages are furthermore restricted due to the oligopolistical market, the lack of adequate storage facilities in the villages, and the exclusive use of bulk packaging at villages during both dry and rainy season.

7. MAIN DEVELOPMENT OBJECTIVES OF THE FAO-ASSISTED SMALL-SCALE FISHERIES DEVELOPMENT PROJECT

The objectives of the Lake Tanganyika Small-Scale Fisheries Development Project are as follows:

(a) first, to ensure that recent declines in fish production are gradually brought to a halt and prevailing trends are gradually reversed. Furthermore, catch productivity should be increased and capital assets more fully utilized. These objectives are to be achieved through the provision of credit in kind of a number of essential inputs such as boats, engines, netting materials, lanterns and various spare parts to initially 10 out of the 21 major fishing communities. Credit arrangements are to be administered by the Cooperative Rural Development Bank of Tanzania (CRDB). The continuity of the scheme is to be brought about through the establishment of a revolving fund which in turn is to be linked to an external project account;

(b) at the post-harvest level, it is planned to drastically improve the efficiency of the processing methods presently in use in order to substantially raise product quality standards.

- For sundrying of clupeids it is envisaged that a number of drying racks be provided to each of the villages. On the spot training and extension would demonstrate to the fishermen the advantages of using a weak brine solution for soaking the fish for a certain period of time prior to sundrying on the racks. This is to reduce the blood content of the fish and produce a more white coloured final product. This is hoped will greatly improve product presentation and enhance marketability.

  By introducing these simple improvements, overall drying time per product shift will be reduced, the product recovery rate improved to about 18 percent and the shelf life of the product extended to about 2-3 months.

  The provision of drying racks and plastic cover sheeting (to protect against the frequent, short showers during the wet season) will form part of the project credit component by CRDB.

- For the smoking of bigger sized fish, it is planned to introduce a number of simple smoking kilns to the villages. These will reduce the amount of firewood required for a given quantity of product compared with the techniques presently in use. Other objectives are to gradually bring about a change in the present fish handling methods at the pre-processing stage and to train the villagers to thoroughly gut and clean the fish, split and brine them for a certain period of time prior to being placed in the smoking kiln.

  It is hoped that by successfully implementing these improved methods product quality standards can be more than doubled, the shelf life extended and the marketability of the processed product extended to new markets further inland of Kigoma.

  As for drying racks, smoking kilns will be provided to the villages on a credit basis.

(c) For product transportation and marketing the following measures are planned:

- to extend additional credit facilities to certain key fishing communities (particularly south of Kigoma) to enable them to acquire their own "water taxis". This is to increase the existing cargo capacities and place the fishing villages in a better position to look for their own marketing outlets and thereby loosen the dependancy on the few visiting fish traders and agents;
- to start an experimental programme of retail packaging of dried dagaa at the village level (100-150 g sealed plastic bags) and to undertake trail shipments of these consumer packs to various centres in neighbouring regions by train. This is to test the technical and financial feasibility of gradually shortening the marketing chain for dried dagaa (for at least part of the total production volume) and to bring about a greater redistribution of benefits back to the producer, both in terms of additional employment and financial returns;
- in the meantime, the collection and compilation of market prices for processed fish in various regional centres around the country will be intensified. It is planned to regularly feed this information back to the village producer in order to improve his bargaining position vis-a-vis the fish trader and agent.

Following from these comments and bearing in mind the various other shortcomings and deficiencies in the area of fish handling and marketing listed above, it becomes apparent, that the successful implementation of the FAO-assisted small-scale fisheries project will only lead to a partial removal of existing bottlenecks facing the industry in the region. Additional measures are therefore required in order to lay the foundation for a more balanced and better organized long-term development of the fisheries sector as a whole.

8. PROPOSED MEASURES FOR RESTRUCTURING THE FISH LANDING AND MARKETING INFRASTRUCTURE IN KIGOMA

The following recommendations should at this stage be interpreted as conceptional ideas and strategy suggestions only [1]. Even if approved in principle, both their technical and financial feasibility would still need to be established. It is nevertheless important that these recommendations be considered in more detail as soon as possible because the fresh fish landing and marketing system in Kigoma is likely to undergo drastic changes with the impending introduction of an additional commercial size purse seiner into the industry: it cannot be excluded that this will lead to an increase in the overall daily landings of fresh fish by about 50 percent within a relatively short period.

(a) Relocation of Main Fish Landing Site for Fresh Fish

The main fish landing site for the semicommercial fishery at Shed Beach should be relocated to a new site across the harbour which is situated just offshore from the Fish Receiving Station at Kibirizi. A small pier or wharf should be constructed in order to facilitate temporary mooring, offloading and servicing of the vessels.

(b) Rehabilitation of the Kibirizi Fish Receiving Station

The Fish Receiving Station - which is already in existence, but due to some technical problems was never commissioned - should be rehabilitated and made fully operational. It should be equipped with ice production and storage facilities and with a small to medium-sized chiller initially. Furthermore, the rehabilitation of the small to medium capacity blastfreezer and cold-storage room should also be undertaken as part of the programme. The Station should also have its own standby generators to make allowance for failures and disruptions in the town's main power supply. The plant should be equipped with bulk fuel storage facilities and order its fuel directly from Dar es-Salaam. This way, operational costs to the fish producer could be quite considerably reduced which would help to at least sustain the present level of profitability of the fishing fleets through increased overall supplies.

A further reduction in vessel operating expenses could be brought about through the bulk ordering of essential servicing and maintenance materials, such as replacement fishing nets, floats, ropes, twines, engine oils, etc.

(c) Organizational Structure of the Fish Receiving Station

The organizational structure of the Kibirizi Fish Receiving Station should take into account the interests of the various producer groups, both small-scale and semicommercial.

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[1] The comments presented below are by no means intended to be exhaustive, but only to outline the general trend of developments envisaged

This could possibly be achieved through equity participation from the various operators which would allow them full Board of Director level representation.

(d) Operations of the Fish Receiving Station

The operations of the Fish Receiving Station should be confined to the purely commercial functions in the areas of fish production, transport, storage, processing and marketing.

Staffing levels and management expertise should be in accordance with ordinary commercial principles: the management should aim for the highest possible degree of operational efficiency; overhead costs and operating margins should be kept at a level which is compatible with allowing both fair financial returns to the producer as well as providing an acceptable price structure to the public.

At the marketing stage a proper wholesale auction system should be initiated. Fish boxes should be used for auctioning and display and for transport and marketing purposes.

In order to guarantee a fair degree of competition, however, the Fish Receiving Station should also have its own small to medium sized truck. The management should make use of this vehicle for its own marketing purposes in cases where auction prices offered by private wholesalers are considered too low.

The Fish Receiving Station should also have its own fish retail section where transactions below a certain volume can be undertaken. This retail section should be clearly separated from the rest of the station complex.

All product which is considered surplus to day-to-day market requirements should be temporarily placed inside the storage facilities. It is anticipated that such a strategy will assist in evening out fluctuations in supply, and greatly help in stabilizing the market so that fresh fish will be available to the consumer in the Kigoma town area on a month-around basis.

Marketing and distribution efforts should also be directed toward supplying the more interior markets, a move which is considered necessary in view of the limited absorptive capacity of Kigoma town for fresh fish. In this context the technical and financial feasibility of regularly supplying iced fish to Tabora by train should be further investigated.

For some time to come, the fresh fish market in Kigoma will almost exclusively remain a price market. Retail packaging of premium products such as cutlets, steaks or fillets is not likely to develop over the next couple of years at least. Consumer demand greatly favours the whole, fresh fish.

As far as the processed fish marketing sector is concerned the Fish Receiving Station should act as an alternative or additional wholesale buyer, thereby increasing the degree of competition in this segment of the market.

When rehabilitating the Kibirizi Fish Receiving Station allowance should therefore also be made for the construction of sufficiently-sized and protected storage facilities for processed fish products. In this context, the physical location of the Fish Receiving Station in close proximity to the Kigoma-Dar es-Salaam railway line is considered to be a great logistical advantage.

The Station should also have a sufficient number of its own drying racks in order to be in a position to react swiftly to occasional market gluts of clupeids.

In summary, it is felt that the suggestions made above would greatly assist in bringing about a better organized and more balanced fish marketing system for the Kigoma region. This would apply to both the fresh fish and processed fish marketing sector. If the scheme succeeds, for example, in raising the general level of FOB village prices for processed fish, this could at the same time lead to a gradual reduction in the illegal exporting of fish across the Lake Tanganyika into neighbouring countries and help to increase fish supplies within Tanzania.

It should, however, be borne in mind that even though the technical and financial implication of such a proposal would turn out to be favourable, the successful implementation of such an undertaking will depend also on managerial factors.

ANNEX 1

Table 1

Annual production of the Lake Tanganyika taken from annual reports of the Fisheries Department

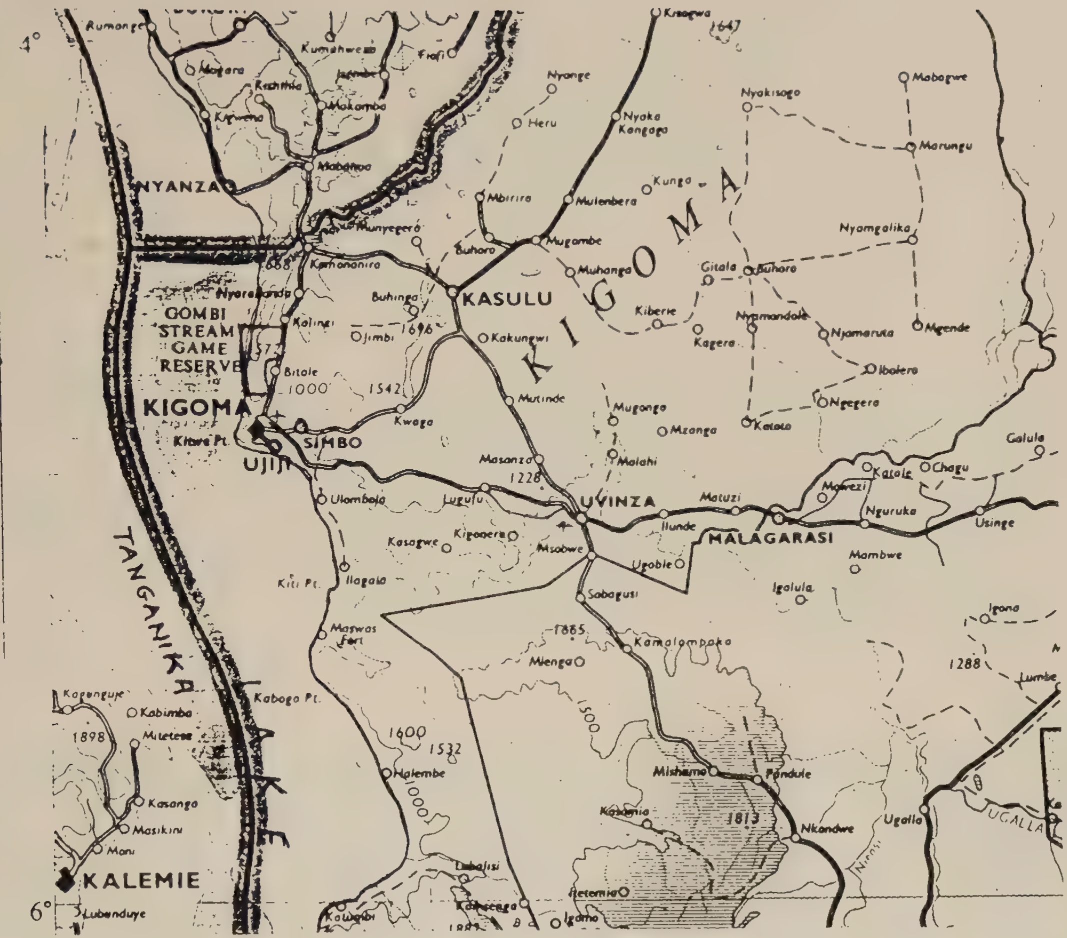
Year	Total catch (t)
1974	76 619
1975	64 347
1976	73 556
1977	61 888
1978	36 456
1979	44 174
1980	38 046

Table 2

List of species obtained by beach seines

	Scientific names	Local names
	1. Table fish	Table fish
1.01	Catfish	Singa
1.02	Boulengerochromis	Kuhe
1.03	L. microlepis	Nouzi
1.04	L. mariae	Sangala
1.05	L. angustifrons	Ngomba-Kibizi
1.06	L. stappersii	Mikebuka
1.07	Euchenoglamis	Kavungwe
1.08	Tilapia	Ngege
1.09	Sinochromis	Kungura
1.10	Barbus	Mbirigi
1.11	Other table fish	Other
	2. Haplochromis	Masembe
2.01	Xenotilapia	Nungi
2.02	Cyathopharyanx	Malala
2.03	L. ambricthys	Misiha
2.04	Limnochromis	Mitununu
2.05	Trematocora	Lulambi
2.06	Synodontis	Kayegeyege
3.00	Limnothrissa miodon	Lumbo
3.01	Stolothrissa tanganicae	Dagaa

Source: "Experimental Beach Seine Fishing on Lake Tanganyika", by E.D. Andrianos, FAO, Rome, 1979, URT/72/008 No. 1, p. 59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Kunga
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Nyamgalika
Buhoro
Mugombe
Kahananira
Muhanga
Gitala
Buhoro
668
Nyarubanda
Buhinga
KASULU
GOMBI STREAM GAME RESERVE
Kalinzi
Jimbi
1696
Kakungwi
Kiberie
Kagera
Nyamandole
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KIGOMA
Mutinde
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Kitwe Pt.
Kwaga
Mzanga
Katolo
SIMBO
UJIJI
Masanza
Malahi
Galula
1228
Katole
Chagu
Mwezi
Ulombola
Luguhu
UVINZA
Matuzi
Nguruka
Usinge
Kasagwe
Kigoa
Msabwe
Ilunde
MALAGARASI
Ugoble
Mambwe
Kiti Pt.
Ilagala
Sabogusi
Igalula
Igona
TANGANIKA
LAKE
Maswas Fort
1885
Kamalampaka
Mlenga
1288
Lumbe
Kapenguje
Kabimba
Kabogo Pt.
1898
Mutetese
1600
1532
1500
Halembe
1000
Mishamo
Pandule
Kasongo
Masikini
Kasanga
1813
Nkandwe
Ugalla
UGALLA
Moni
KALEMIE
Lubalisi
Katumba
Retemia
Igamo
Kalwibi
Lubenduye

Map 1

RECENT TRENDS IN FISH UTILIZATION AND MARKETING IN ZAMBIA

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ABSTRACT

Trends in fish utilization in Zambia are reviewed and factors responsible for the recent shifts in utilization are identified. Out of the total fish production of 55 000-60 000 t, 35% is consumed fresh, 30% is hot smoked, 25% is sun dried, 9% is frozen and about 1% is canned. The development of fisheries for kapenta in Lake Kariba and for other small species in the northern lakes have increased the quantity of fish cured by sun drying. More fish is now being utilized for freezing and canning, but the quality of the products needs improvement. Adoption of strict quality control measures is suggested in order to achieve wider acceptance of these products in the domestic market and to enter foreign markets.

1. INTRODUCTION

The present level of fish production in Zambia is estimated at 55 000-60 000 t. While earlier studies (Beatty, 1969; Clucas, 1976) indicated that about 80% of the fish caught is marketed in the dry form, Williams (1977) suggested that only 55% of the fish utilized is in this form. Fish production and utilization in the country during the last decade have significantly changed, accentuated by a combination of factors such as the development of a commercial fishery far kapenta (sardines) in Lake Kariba, expansion of industrial fishing for kapenta in Lake Tanganyika, development of the fishery for chisense (a mixture of clupeids and minnows) in Lakes Mweru (Luapula), Mweru-Wa-Ntipa and Bangweulu, increased facilities for freezing, storage and transportation, improvements to the road communication network particularly in the northern lakes, drastic import reductions in fish and fishery products, increased production from the aquaculture sector, and above all changes in the socio-economic position of the producer and consumer. This paper briefly reviews current trends in fish utilization in Zambia.

2. GENERAL TRENDS

Market statistics collected for the period 1979-83 from various fishery areas indicate the proportion of fresh fish to dried fish as 24.6:74.4 (Table 1) which is an increase of about 3% for fresh fish since the earlier survey (Beatty, 1969). However, these surveys did not take into account fresh fish consumed at landing centres or sold directly to the traders at or enroute to landing centres, and the quantity of fish landed by commercial and industrial operators.

Since the mid seventies, the import of fish and fishery product, particularly frozen and canned products, has been reduced and today these imported commodities are insignificant. A noteworthy change in utilization is the importance assumed by the small fish species kapenta and chisense, which largely form the basis for the "relish" of the rural population and the low income group. The fishery for kapenta in L. kariba has developed rapidly since 1980 and production reached nearly 5 000 t in 1983. Similarly, kapenta production from Lake Tanganyika has increased during the last few years due to an expansion of industrial fishing. Based on the data available for 1983-84, production of kapenta and chisense amounts to 15 000 t, most of which is sun dried. This together with other sun dried species constitute 25% of the fish landed. This supply of sun dried fish is augmented by about 750 t of kapenta entering the country from Tanzania. It is also estimated that a further 30% of the catch is cured by smoking. Fresh fish (including iced fish) consumption is estimated at 35%, the remainder being consumed as frozen (< 7%) and canned (< 1%) products.

3. FRESH AND ICED FISH

The fresh fish trade is mostly based on artisanal catches from different fishery areas and localized fish farms and ponds. Although no reliable data is available on the quantity of fresh fish consumed in the fishery areas or the iced fish transported from the major landing centres, it is estimated that a total of 18 000-20 000 t of fish is utilized in the fresh form. With the importance attached to fish-culture development in the country and the improvements in the communication network, fresh fish is expected to contribute to a greater part of fish consumption in the near future. Fresh fish is much preferred by consumers and usually bring better returns to the fishermen.

Table 1

Average percentage of fresh and dried fish sold in the markets of major fishery areas (1979-80)

Fishery areas	Fresh fish	Dried fish
Tanganyika	32%	68%
Mweru-Wa-Ntipa	20%	80%
Mweru (Luapula)	42%	58%
*Bangweulu	2%	98%
Kafue	18%	82%
Kariba	37%	63%
Lukanga	12%	88%
Upper Zambezi	34%	66%
Average	24.6%	75.4%

*Based on inadequate data.

In the fresh fish trade, fish is purchased at the landing centres by traders, who use 5-6 t lorries, fitted with an ice-box. Traders carry blocks of ice and store them in saw-dust at the collection centres. Crushed ice is layered with fish until the box is full with 2-3 t of fish and 1-2 t of ice. The transportation of fish from the northern lakes takes usually 24-36 hours depending upon the camps visited and the distance to the main outlet market. According to Robinson (1973) the average cost for transportation is 150% of the cost of fish and in extreme cases is 3-4 times the cost of the fish. As a result the fresh fish in the urban markets is exhorbitantly expensive. An organized distributional network for iced fish is lacking in the country. The collection points in most cases have no chill rooms or provision for the supply of ice, and the distribution points are without adequate cold storage facilities.

4. FROZEN FISH

The frozen fish trade in Zambia has shown a steady increase particularly since 1980, much of which is supported by the industrial fishery of Lake Tanganyika. Table 2 indicates the species and quantities of fish utilized for freezing during the past five years. The quantity of fish frozen has more than doubled over this period. The supply is far below the demand, especially in the urban outlets. Kapenta and nvolo (Lates stappersii) constitute over 90% of the frozen products. Other perches and their fillets contribute about 10%.

Most of the industrial operators of Lake Tanganyika have their own freezing, storage and refrigerated transport facilities. Blast freezers are widely used in the processing plants.

In 1984 out of about 4 000 t of frozen fish marketed, 600-650 t were distributed to the markets of Lusaka, 1 800-2 000 t to the Copperbelt and about 1 200 t to the nearby urban outlets of Munla, Kasama, Mpika and Mkushi. The state-owned supermarkets constitute the principal outlets for the frozen products.

Kapenta is frozen whole and packed in 500 g polythene bags, whereas nvolo, frozen whole, is packed in gunny bags or in 20/25 kg cartons. Larger perches are usually frozen without gutting. Two species of perches L. angustifrons and L. mariae are filleted and the fillets sold in 500 g packs. The perch fillets are extremely popular among the high and middle income groups and the hotel industry. The consumer preference for frozen products is overwhelming, and utilization of frozen products is expected to increase substantially in the future.

5. CANNED FISH

Since 1981 commercial production of canned fish has started. Two companies specializing in the manufacture of food products have recently diversified into fish. The canned products are predominantly of kapenta from Lake Tanganyika. Small quantities of Kariba kapenta, bream and nvolo are also being utilized for canning. The products include curried fish and fish in tomato and spiced sauces. Out of 465 t of fish utilized in 1984 for canning, kapenta constituted 440 t and the rest

Table 2

Fish utilized from Lake Tanganyika for freezing purposes in tons
with the percentages in parenthesis (1980-84)

Year	Sardines (kapenta)	Nvolo *Lates stappersii*	Perch		Perch fillet	Total
			Pambo *L. angustifrons/ L. mariae*	Nyunvi *L. microlepis*		
1980	428(31.8)	803(59.7)	51(3.8)	47(3.5)	15(1.1)	1 344
1981	700(43.1)	780(48.1)	75(4.6)	46(2.8)	20(1.2)	1 621
1982	1 220(70.2)	384(22.2)	58(3.3)	48(2.7)	26(1.5)	1 736
1983	1 029(38.2)	1 467(54.4)	94(3.5)	75(2.8)	30(1.1)	2 695
1984	2 386(63.9)	1 047(28.0)	194(5.2)	86(2.3)	46(1.1)	3 733
Average	48.4%	42.4%	4.1%	2.8%	1.2%	

were nvolo and breams. Because canned products can be distributed and stored easily, they are becoming popular even in rural areas. The quality of product needs improvement, particularly of kapenta because the fish is generally canned whole without eviscerating. Adoption of quality control practices including the bacteriology of the raw fish and gutting prior to canning might improve the situation appreciably.

6. CONCLUSIONS

In recent years fish utilization in Zambia has changed conspicuously. There is an increasing consumer preference for fresh and frozen fish, particularly in urban areas and this offers considerable scope for further expansion. However, adequate storage facilities at landing, processing and distribution centres are limiting factors. Dressed fish and fillets in convenient packs of 0.5 kg or 1 kg will have more sales potential than whole large fish. Further diversification into products like fish fingers, fish sausages and minced fish also offers market potential. This is more as in the case of fish species which are not well accepted by the consumers in fresh and dry form, e.g., dried nvolo, and fresh and dried barbels. Import restrictions on frozen and canned fish products have resulted in the development of local processing industries to substitute these products. Excepting the small quantity of dried fish coming in from the neighbouring countries, the import is now limited to fish meal for stock feeds. Canned and frozen products particularly nvolo and perch fillets also offer avenues for export. In 1984 a small consignment of frozen nvolo was exported to a neighbouring country. The fish canning and freezing industries should improve the quality of their products through strict control and monitoring measures in order to achieve wider acceptance in the domestic sector and to enter the highly competitive foreign markets.

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SESSION 5:

QUALITY CONTROL AND INSPECTION/
CONTROLE DE LA QUALITE ET INSPECTION

QUALITY OF FISH IN KENYA AND EXISTING PROBLEMS

by

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ABSTRACT

This review paper on quality of fish has been compiled after extensive collection of data and facts on all aspects of the fishery industry in Kenya. Consultations, interviews and surveys for this work were carried out at the Fisheries Department, Kenya Marine and Fisheries Research Institute, fish landing sites along the Indian Ocean coast and around Lakes Victoria and Naivasha. Fish processing installations, markets and quality standards were also assessed.

It was discovered that consumption of fish is increasing. The present fish catch in Kenya has passed 80 000 t/year. This is largely finfish, plus crustaceans and molluscs. Availability of good fish to consumers is, however, frustrated by the ignorance of the majority of dealers, processors and retailers about quality methods in distribution, processing, storage and marketing. Other factors responsible for the prevalent poor quality include lack of published quality standards, and inadequate quality inspections. The current practices in all stages of the fishery industry fall short of modern technological and health recommendations, except in a few instances when fish is prepared and handled for special markets and hotels mainly in towns or for export. Common practices expose fish to unfavourable environmental conditions (high ambient temperatures, moisture, flies and dust) that enhance spoilage and contamination. Renovation and improvement of the industry needs better forms of preservation technologies, both traditional (drying and smoking) and new (chilling and freezing). Implementation of quality standards, as well as education of the public and all concerned in quality aspects, are advocated if quality is to improve to a generally acceptable level.

1. INTRODUCTION

1.1 Production Statistics

Fish means vertebrate fishes (except trout), crustaceans and molluscs (Kenya, Government, 1968). In Kenya, fishermen have been organized into cooperatives. The fishing cooperatives receive assistance from the Government in the form of fishing nets and landing facilities. Fishermen hire fishing vessels (canoes and boats) and other equipment from richer individuals and cooperatives through whom fish is sold to buyers at the landing site. Cooperatives supply statistics to the Government and also unify prices. The Fisheries Department supervises the fishing operations through the cooperatives.

Fishermen usually start fishing very early in the morning or at dawn, and they bring their catch to the landing site by midday. Some fishermen still like to use shores and beaches which are not scheduled cooperative landing sites. A landing site is a raised concrete cement platform with a roof. At this point, fish quality inspectors check the quality of fish as it is sorted out for sale. Available statistics show that the amount and monetary value of the fish catch has been increasing yearly, especially in inland waters. Table 1 shows recent statistics, and Table 2 shows the most common species of fish caught.

From Tables 1 and 2 the total weight of fish produced in 1982 was 81 133 t valued at K.Sh. 219 million at the beaches and K.Sh. 657 million at retail. Lake Victoria produced 75% of the catch; marine fish formed 9%. The total weight of fish catch increased over the 1981 production by slightly over 40%, which in turn was 19% higher than the 1980 figure of 48 219 t. In 1965 total fish catch was 23 000 t. Most fish is consumed locally in the fresh, dried or smoked form.

Table 1

Quantity and value of fish to fishermen at various fishing areas in Kenya, 1982, and totals including foreign trade values for the years 1980-82 (Kenya, Fisheries Department, 1983)

		Tons	K.Sh. '000
Freshwater fish:			
Lakes Victoria		60 958	123 400
Turkana		11 040	12 033
Baringo		401	768
Naivasha		411	5 735
Others		315	1 078
Ponds		440	24 819
Rivers and dams		452	1 103
Total		74 017	168 936
Marine fish (Indian Ocean):			
Fish		6 622	40 988
Crustaceans		426	8 237
Other products		68	1 606
Grand total	1982	81 133	219 787
Retail price	1982		657 163
Grand total	1981	57 352	164 026
Grand total	1980	48 218	109 317
Foreign trade:			
Exports (mainly dried, salted or smoked fish, fresh or frozen fish fillets and crustaceans)	1982	911.8	22 529
	1980	784	7 383
Imports (mainly fish meals, salted, dried or smoked fish and canned products)	1982	970	6 639
	1980	3 757	20 051

Foreign trade includes crustaceans and fillets that are exported to Europe, e.g., France and the Netherlands. Dried fish from Lakes Victoria and Turkana are packed and sold to Zaire and Rwanda. Major imports come from Somalia, Saudi Arabia and the Netherlands.

1.2 Production Problems

Current specific problems that affect the supply of fish in Kenya include the following:

(a) the increasing number of Nile perch in Lake Victoria since its introduction there in 1960 is, by the predatory habit of this fish, causing other fishes, particularly the delicious tilapia, to dwindle in numbers. In 1982 the beach price of tilapia per kilogramme was K.Sh. 5.28 (=US$ 0.50), compared to that of Nile perch at K.Sh. 1.82. The retail price is about three times these figures;

(b) the spread of salvinia weed on Lake Naivasha limits the scope for fishing. Kenyans probably need to import the parasitic aquatic beetle which, according to recent reports, has been used by scientists in Australia to control this weed;

Table 2

List of most common species caught in Kenya
(Fisheries Department, 1983)

Lake Victoria (freshwater fish)			Indian Ocean (marine fish)			
Scientific name	Local name	tons	Scientific name	Common name	Swahili	tons
Engraulicypris	Omena/ Adel	10 419	Demersal:			
			Siganus oranium	Rabbit fish	Tafi	651
T. nilotica	Ngege	2 581	Luthrinus nebulesus	Scavenger	Changu	721
T. esculenta	Mbiru	339				
Others	Obudi, etc.	1 496	Lutianus	Snappers	Cheusi, Tembo	293
Haplochromis	Fulu	2 546	Callyodon guttatus	Parrot fish	Pono	173
Alestes	Osoga	2	Pomadasys operculara	Spotted grunter	Pamamba	96
Lates	Nile perch/ Mbuta	33 134	Gaterin sordidus	Black skin	Fute	108
Mormyrus	Suma	219	Epinephelus sp.	Rockcod	Tewa	255
Bagrus	Sewu	2 678	Ictalurus nebulosus	Catfish	Fume	64
Barbus	Fwani	2 532				
			Pelagic:			
Clarias	Catfish/ Mumi	682	Mugil cephalus	Mullets e.g flathead	Mkizi	155
Protopterus	Lungfish/ mudfish, Kamongo	2 062	Rastrelliger spp.	Little mackerel	Kiboma	39
Schilbe	Sire	78	Caranx spp. Scomberomorus spp.	King fish King fish	Kole-kole	209
Synodontis	Okoko	239	Chorinemustol	Queen fish	Pandu	72
Small mixed fish	-	961	Thunnus sp. Euthunnus sp.	Tuna, Jacks	Jodari	324
Trout/ Salmon	-	-	Chanos chanos	Milkfish	Mwatiko	42
			-	Barracuda	Tengesi	68
			-	Dolphin	-	12
Total		60 958	Mixed demersal and pelagic	-	-	400
of which fresh use		29 554				
processed		31 404				
			Others:			
			Hydrolagus sp. Isurus sp.	Shark	Papa	265
			Sardinella	Sardines	Simu	418
			Crustaceans (crabs, prawns,lobster) Octopus and Bêche de Mer			540
Total		60 958	Total			7 116

(c) another problem relates to lack of ready markets for fish caught in areas far from population centres. At one time, two years ago, surplus dried fish in Lake Turkana had to be burnt to dispose of it;

(d) there is need for widespread fish-farming in the country as well as the manufacture of new fish products. Presently, FAO is promoting marine fish-farming at Malindi and also rehabilitating fish-farming ponds in the Lake Victoria Basin to increase the supply of selected crustacea and finfish. There are also plans to establish a fish-farming research centre at Sagana, north of Thika. Other proposed enterprises that would be welcome include establishing fishmeal production using haplochromis in Lake Victoria (Jansen, 1973) and a fish cannery at Mombasa.

1.3 Quality Level of Fish

Under the high ambient temperatures encountered in the tropics, the post-harvest spoilage of fish (due to attack on fish flesh by natural enzymes or parasitic nematodes and protozoa) is very rapid (Connell, 1980). Fish spoils faster than any other foodstuff, apart from milk, and unless measures are taken to preserve quality, fresh fish spoils, loses its firm structure and smells bad within 24 hours. On the other hand, the shelf life for many species of fish goes up to 30 days when in ice (Jones and Disney, 1977; James, 1977). Unfortunately, in Kenya, chilling of fresh fish and freezing are carried out only on a small scale by dealers and processors who supply fish to special markets. Fresh fish and processed fish (including fillets) bought by dealers and fishmongers from landing sites and warehouses, are in most cases packed in baskets, gunney bags, or polyethylene and transported without cooling on foot, bicycles or in vehicles. Traditional processes for preserving fish, such as sun-drying and smoking methods are more available than cooling methods. The traditional processing is generally poor and consequently the product has a short shelf life, at times only two days, and is easily infected with maggots and moulds. Fish also becomes bitter due to rancidity. At display for sale, as at processing, fish is exposed to insect activity, such as house flies and also to contamination with dust and sand. Fish in markets are in many cases already spoilt before it is bought by consumers, including those who may have refrigerators at home.

Tests carried out by Binta (1978) show that fish bought in Nairobi markets have total bacteria counts of 10^5 to 10^{10} per gram of fresh ocean fish and 10^3 to 10^7 per gram of smoke dried fish from Lakes Victoria and Turkana. No signs of *Salmonella* or *V. cholera* were detected, particularly in processed fish; but *V. parahaemolyticus* was common in all samples. The microflora were either inherent or through acquired subsequently through unsanitary handling and processing. For *V. parahaemolyticus* the infecting dose to cause poisoning or diarrhea appears to be an intake of 10^5 and 10^7 viable cells of the organism. The effect varies with resistance of the individual consumer (Binta, 1978). Luckily, among Kenyan communities fish is eaten only after it is cooked.

2. METHODS EMPLOYED TO ENSURE FISH QUALITY AND PROBLEMS WHICH LIMIT THE QUALITY

In order to ensure quality of fish, proper means and conditions need to be employed (raw materials, machines, methods, etc.); thus, quality assurance is being promoted in Kenya by relevant Government departments. In addition, quality control inspections are carried out by the Fisheries Department.

2.1 Quality Assurance

The following activities have been recommended and are being promoted in the industry. Adoption of the recommendations is, however, still lagging behind:

(a) fish should normally be gutted at sea by fishermen. Currently, because of various reasons this is rarely done. Sometimes because there is only one fisherman in the canoe, he has no time to accomplish this task;

(b) to minimise spoilage during distribution, the fish catch should be transported in the shortest time from the sea to land and onward to consumers. Present conditions are such that canoes have no engines and hence sail at the slow pace of paddles, therefore the fish is exposed for long periods in open sun. This period is extended when fishermen are forced to go from one landing site to the other, looking for buyers. There are no cool stores in the canoes, or on shores. In addition, on land, fish is generally transported in baskets without cooling and in some areas the journey is tedious and long due to poor infrastructure;

(c) at landing sites, fish should be washed with cold water and, if not sold immediately, should be chilled in a solution of 2% sodium chloride and maintained in a cold room at between 0°C and -2°C until processed within a maximum of six days; after that, unless frozen or dried, they should be chilled again for transport or storage and marketing. Two percent sodium chloride has an osmotic pressure equivalent to tissue fluids. Despite this recommendation, no chilling or freezing are carried out during general distribution, processing, storage and marketing of fish in this country;

(d) fishermen and processors are instructed to discard any fish that have diseases or are known to contain harmful substances, or those which have undergone deterioration and decomposition. Equally, quality inspectors should discard or impound any fish that are spoilt or contaminated;

(e) to reduce contamination, proper storage and display equipment is needed by wholesalers, as well as retailers to cover their products; at present a lot of flies land on fish at markets and these may spread serious diseases to consumers. Another need is that fish and surfaces which come in contact with it should not be contaminated with pesticides or insecticides and other harmful substances. On the contrary, there are instances in Kenya when some ignorant retailers keep off flies by directly spraying insecticides in the display cabinet.

2.2 Quality Inspections

Quality inspection is based only on the Public Health Act (CAP 254) on Food, Drugs and Chemical Substances, because no elaborate fish standards exist. National standard specifications and codes of practice for the fish industry are still under preparation. Present inspections are therefore limited in scope and details. Only organoleptic checking is done and no tests are carried out. During quality inspections, several organs of fish are checked. Good quality fresh fish should have: flesh which is firm and elastic and without any trace of browning; eyes which are bright clear, full and transparent; gills which are bright red and free from slimes; skin which is shiny and irridiscent; a pleasantly fresh and mild odour. Flesh, eyes and gills go opaque or brown when fish becomes stale. Premises and facilities used for transport, processing, storage and marketing of fish are also inspected to establish their hygienic conditions and fitness for use for purposes of licences and regular surveillance by the Department.

On surveys one often notices that the condition of fish in many markets and premises is not excellent. The main reason is an apparent ignorance by both dealers and consumers of quality requirements; also common is a lack of proper processing and handling facilities, such as refrigeration and cabinets. All this limits consumer demand for fish.

3. DISCUSSION AND CONCLUSIONS

Fish consumption continues to rise in all areas of Kenya because on a weight basis it is still the cheapest source of animal protein (Kenya, Fisheries Department, 1983). Because fish spoils quickly, the present operating conditions restrict consumption of good fish to communities who live close to fisheries. Efforts by a few dealers and processors who use vans that are refrigerated or loaded with ice also enable specified markets and hotels in towns to receive well preserved fresh fish, fillets and crustaceans. Such improved methods are likewise employed for fish going to export trade. Fresh or processed fish reaching the bulk of consumers in both rural and urban centres are packed in baskets, and distributed and marketed in ambient conditions because cold store facilities do not exist; this means that at least 70% of Kenyans are living in areas where good quality fresh fish is not obtainable. Traditional processing is crude and poor because there are no established procedures to follow. Temperatures and final moisture contents are not controlled, and are often inadequate to inactivate enzymes and micro-organisms. Sun drying of split fish and small whole fish is done on straw mats or on wooden platforms exposed to the elements. Likewise, conditions for smoking fish over kilns or for preserving pieces of fat fish, e.g., Nile perch and herring by frying, are not controlled. Accordingly, huge amounts of fish, quite often over 15% of the processed product, is lost due to many forms of spoilage and contamination. Another problem is the disintegration into fragments of overdried fish. To improve sales, dealers and retailers sometimes polish the dried or smoked fish with oil to improve the appearance although the quality may not be fit for human consumption.

The Government is responding with concern to reduce these problems in the industry and to enhance utilization of fish in the country. Through relevant departments, the Government has constructed refrigeration and cool storage facilities at half a dozen landing sites along the Indian Ocean coast, at Lake Baringo, and in a few fresh fish markets in cities like Mombasa, Malindi, Nairobi and Kisumu. Unfortunately, in some cases where facilities have been built, retailers (out of negligence) continue to sell fish without cooling, leaving the facilities which they have unused. In view of this, necessary improvement of quality in the fish industry awaits implementation and promulgation of national quality standards that are still at draft stages. The two standards presently under preparation by the Kenya Bureau of Standards are: (i) code of practice for handling, processing and distribution of fish, and (ii) specification for dry salted fish. The standards will be used for quality control in all sectors of the industry. They will also be applied as information material for fishermen, dealers, processors and consumers in Kenya so as to improve their appreciation of quality and handling conditions. This will ensure better production and distribution of good quality fish for local consumption and export. Finally, it should be noted that fish quality, as expressed in this paper with particular reference to Kenya, is a fair representation of the case in all those East African countries with which Kenyans share major fishing waters, culture and fish handling practices.

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PROBLEMS OF INTRODUCING QUALITY CONTROL FOR FISH AND FISHERY PRODUCTS WITH REFERENCE TO TANZANIA

by

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ABSTRACT

Tanzania has a fish production estimated at over 200 000 tons (1983). The fish is sold in fresh and cured forms. A small portion of the processed fish is exported to markets in neighbouring countries. Frozen crustacean products are exported to earn foreign exchange. Presently there is no proper system for controlling the quality of the fish and fishery products.

The paper examines the merits of introducing quality control measures for fish and fishery products and the problems encountered. It goes on to state the need to set up a quality control laboratory for fish and fishery products.

1. INTRODUCTION

Fish is one of the most perishable foods due to the high content of low molecular weight metabolites which are available for microbial nutrition. Thus, fish is very vulnerable to spoilage especially in the tropics where the high temperatures catalyse autolytic spoilage and bacterial growth.

Fish, once out of the water, rapidly spoils and unless spoilage is controlled fish and fishery products rapidly become unacceptable to a quality-conscious consumer. It is also possible that food poisoning can develop in the fish to the detriment of the health of the consumers.

1.1 Quality Control Policy

Quality control can be viewed as a set of measures taken to retard spoilage and to ensure the fish reaches the consumer in a wholesome condition. The measures to be taken may include ensuring the quality of the fish to be processed, the processed fish, as well as the environment in which the fish is handled, processed, packaged, transported and stored. Maintenance of quality demands continuous inspection of the fish from the time it is caught to the time it reaches the consumer. Freshness of fish in all stages of the distribution chain is a major concern of any quality control programme.

Tanzania does not have strict quality control measures although the Agricultural Produce Ordinance empowers the produce inspectors to condemn any agricultural produce (fish implied) which is not fit for human consumption. The Fisheries Act (1970) and its Principal Regulations (1973) provide for the enactment of regulations to control the quality of fish and fish products under part IV section 7 subsections 2(s), 2(u) and 2(v). These Regulations also provide for the protection of the processing environment under part IV section 7 subsection 2(w) to ensure the consumer gets a wholesome product.

Public health authorities are concerned about consumers receiving food, including fish, in a condition fit for consumption. However, no regular inspection is done of fish and fish products. Any fish suspected to be injurius to health can be brought to the attention of the Chief Government chemist who will carry out the required analysis to confirm the condition of the fish. The batch of fish whose samples are found unsuitable for consumption is condemned and any person suspected to have caused the condition can be brought to justice.

In practice very few consumer complaints are registered with the legal authorities and these do not reach a stage where legal action can be taken.

The scarcity of cheap animal protein has caused a high demand for fish which leaves no room for quality complaints. Instead it forces the authority to relax enforcement of quality regulations under the moral consideration that low quality fish is better than none to a consumer who has no other source of protein.

1.2 Fish Production and Fish Quality

Tanzania's fish production exceeded 260 000 tons in 1983. An estimated 95% of the catch is landed by over 50 000 traditional fishermen who are scattered at numerous landing beaches. These fishermen have no facilities for preserving the catch before it is brought to the market or processing site. Most of the vessels operate close to the shore but may have a sailing time of up to 6 hours before they can reach their fish landing beaches. Motorized fishing boats are few and often the engines are out of order.

Some of the fish landing beaches are far from the main consumer centres which necessitates transportation of the fish to the consumer markets usually under very difficult conditions.

The remoteness of the markets for freshfish has limited the fish which can be sold fresh to an estimated 20%. The rest of the catch is processed by sundrying, smoke-drying and at times salting before it is packaged and transported to the markets. Processed fish is distributed in most parts of the country.

The use of ice for maintaining the freshness of the fish before it reaches the market or processing site is very limited. Consequently, the fish reaching the consumer and processing sites is several hours old and at times in a stale condition. The maintenance of quality of fish by the small-scale fishermen is on this account very difficult.

Commercial fisheries account for less than 5% of the catch. The commercial fishing vessels have facilities for carrying ice and fish containers. The fish is iced immediately after it is caught, stacked in containers, mixed with ice and kept in the fish hold.

The fishing trawler "Mama TAFICO" has facilities for quick freezing prawns to maintain their export quality. Fish from the commercial fleet is easier to subject to inspection and quality maintenance but so far quality control is not enforced because of the high demand for fish. This makes the product very expensive whilst adherence to good quality standards is not demanded.

1.3 Foreign Trade in Fish and Fishery Products

Tanzania does not import significant quantities of fish and fishery products. If imported then it is assumed they would be in a condition suitable for human consumption. No quality control tests are known to have been applied to imported fish and fishery products.

Limited quantities of Lake Tanganyika sardines locally called "dagaa" (*Stolothrissa tanganyikae*), and Lake Victoria lung fish, locally called "kamongo" (*Protopterus aethiopicus*), are exported to neighbouring countries. No quality requirements are prescribed for these products although the Fisheries Act (1970) requires the exporter to have an export licence issued by the Director of Fisheries. Frozen prawns are sold locally and in external markets.

In 1983, 114.2 tons of prawns were exported, earning the country over 6 million Tanzanian shillings in foreign exchange. To safeguard the export market, dealers in prawns are required to have suitable premises for processing, packaging and storage before they can be issued with a licence. A total of 12 prawn exporters were registered with the Directorate of Fisheries in 1984. For each consignment to be exported, the exporter has to have it inspected physically by an official of the Directorate of Fisheries to verify whether it is of good quality before he pays an export royalty. The exporter is issued with a certificate of health and a certificate of origin where these are required by the importing country. There is no quality control laboratory for fish and fishery products in the country.

1.4 Merits of a Quality Control Programme

The introduction of a quality control programme will have the following advantages:

(i) act as an economic safeguard by ensuring: -

  (a) products on the market are fit for human consumption and in this way protect the health of the consumer;

  (b) high nutritive value;

  (c) lower losses of nutritive and economic value. In this way the consumer is assured of his money's worth as he will buy a wholesome fish with quality protein and high nutritive value;

(ii) remove economic frauds involving adulteration or misbranding, like polishing a smoked, stale fish to make it attractive to the consumer;

(iii) abolish offences against decency like the distribution of decomposed or filthy fish;

(iv) minimize offences endangering public health such as sale of products with added or accumulated poisons, like insecticides, heavy metals, harmful bacteria toxins and disease producing bacteria;

(v) expand the market by establishing a good product market reputation and a demand for the products in local and external markets. This will increase earnings from the fishery industry.

1.5 Problems of Setting Up a Quality Control Programme

The establishment of a quality control programme will encounter the following problems:-

(i) the scattered nature and remoteness of landing centres will make it difficult to enforce quality standards applied to small scale fishermen unless major improvements are made to provide for chilling of the fish immediately after it is landed and to quickly transport it to the market;

(ii) lack of a laboratory to carry out quality assessment (organoleptic, bacteriological and chemical). Such a laboratory is important to ensure required quality standards are met. A network of quality control laboratories would be required if an effective system is to be introduced to cover the whole country;

(iii) the poor economic condition in the country does not favour the establishment of quality control standards:

  (a) there is no incentive for selling a product of good quality because the price difference between a low quality and first class product is very often negligible;

  (b) there is a very high demand of fish irrespective of the quality;

  (c) low purchasing power forces some consumers to buy anything that gives them a taste of fish;

(iv) lack of consumer awareness of the meaning and importance of quality control undermines quality adherence;

(v) cultural differences in eating habits make it very difficult to have an acceptable national consensus on quality grades;

  (a) some cultures will only admire and accept a fish product if it is a bit stale;

  (b) other cultures hold the view that keeping fish on sand and handling it roughly improves its quality;

(vi) lack of hygiene consciousness among fishermen makes them handle fish unhygienically on fishing vessels and the same thing happens during processing, storage, marketing and distribution operations.

2. CONCLUSIONS AND RECOMMENDATIONS

The introduction of quality control for fish and fishery products is difficult to enforce in a society where there is a high demand for fish, and fishermen and fish consumers are not conscious of the need to establish and adhere to quality standards. The scattered nature of fishlandings from the small-scale fishermen makes it difficult to organize and operate a quality programme. For a successful quality control programme to take off the following considerations are vital:

(i) fishlandings have to be centralized to facilitate fish collection, proper handling, chilling, storage distribution and maintenance of hygienic conditions;

(ii) mass education and training on the need for a quality control programme has to be undertaken to ensure the meaning of quality assessment and control is understood and that it is socially and culturally acceptable to the fishing community, fish traders and fish consumers;

(iii) the prices of fish should relate to the quality and protein value in order to act as an incentive for fishermen and traders to maintain high quality standards. High quality fish should fetch the highest prices;

(iv) establishment of a quality control laboratory for fish and fishery products will assist in ensuring that the required standards are maintained especially for the sensitive export market;

(v) the expansion of the prawn industry as a foreign exchange earner will depend on a reputation for exporting high quality products. A quality control laboratory could initially be vested with ascertaining the quality of prawns earmarked for export. This will ensure Tanzania remains competitive in the prawn export trade;

(vi) the Food and Agriculture Organization (FAO) should consider assisting in establishing a quality control laboratory in the country. This laboratory will act as a nucleus for a network of such laboratories.

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THE NATIONAL QUALITY CONTROL SYSTEM FOR FISH AND SHRIMP IN MOZAMBIQUE

by

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ABSTRACT

The shrimp fishing industry in Mozambique is very important to the economy of the country. For this reason the Secretariat of State for Fisheries has mounted, within the Department of Fish Technology of the Fisheries Research Institute, a programme for the development of a "National Quality Control System" which, in its first phase, is directed primarily toward the shrimp industry and the establishment of a quality control system inside the state-owned fishing industries. The paper describes the industry and analyses its problems. It presents the results of quality analysis, conclusions and details of corrective actions which the Project has initiated, together with some preliminary results of these actions.

1. INTRODUCTION

The shrimp industry is one of the Government's principal priorities, as shrimp is a strategic product for exportation. With the production of shrimp close to its maximum sustainable yield and considering the constant elevation of quality standards in the world fish market, it became apparent that a reliable and competent system of fish inspection and quality control was necessary in order to support the Government's efforts to increase the value of exports and defend it in the foreign market. In 1981, a project was defined to create a national quality control system which commenced in 1982 financed by UNDP. The immediate objective of the project was to establish the above system initially aimed at improving the quality of seafood for export and training of local technicians. Two fish inspection laboratories capable of carrying out microbiological and chemical tests were to be equipped in Beira and Maputo, as well as inspection stations in Quelimane and Angoche. The service would carry out sampling and analysis of products for export and, in cooperation with the local competent authorities, issue appropriate export certificates.

The Project was also to furnish technical assistance to the various fisheries sectors with regard to the practices of handling and processing which are required to meet inspection standards, prepare guidelines, instructional modules and train technicians in the service and productive sector.

2. ORGANIZATION OF THE PRODUCTIVE AND COMMERCIAL SECTORS AND THE INSERTION OF THE PROJECT IN THE SECRETARIAT OF STATE FOR FISHERIES

The Secretariat of State for Fisheries (SEP) has two directorates which encompass the productive enterprises:

(a) Central Direction for Industrial Fisheries (UDIP), which directs the national enterprises that capture shrimp (Emopesca - Beira, Quelimane and Angoche) and three joint ventures (Japan, Spain and USSR), as well as the industrial sector in general;

(b) Central Direction for Small-Scale Fisheries (UDPPE), for cooperatives, artisanal fishermen, etc.

The Secretariat of State for Fisheries is under the Ministry of Industry and Energy and is termed the productive sector. It sells its product to the commercial sector - Ministry of Foreign Trade for shrimp - and Internal commerce for fish who, in turn, sell the product on the market. For shrimp the commercial sector operates its own system of quality control which is a 100% end-of-line inspection system for accepting or rejecting shrimp for export.

The three national companies that capture shrimp have a myriad of problems, partly due to insufficient managerial and technical expertise on the spot, and an ageing fleet. At the beginning of the Project there was also a dissociation of the productive and commercial sectors, whereby price and quality had no influence on the financing and capture. This resulted in everyone being obsessed with production and a general lack of motivation to improve quality. This, coupled with local factors that made workers more interested in fish than shrimp and organizational problems of discharge, lack of storage space within freezing rooms for separation of lots, poor transportation arrangements from Angoche and Quelimane and constant breakdown of freezing equipment, all frustrate the implementation of food practices and quality control within the companies.

The project for the establishment of a national quality control system (SNCQ) was localized within the Fish Technology Department of the Instituto de Investigacão Pesqueira (IIP) within SEP and has its principal fish inspection laboratory in Beira. The relations between the project and the productive and commercial sectors for shrimp is characterized in Annex 1.

3. STRATEGY

The Project's principal aim was to establish a quality control and inspection service which would assist in the improvement of quality. Given the number of personnel available and the nature of the problems, it was decided that inspection (issuance of health certificates) must remain within an independent institution, creating perhaps in the future an independent inspection service, but that the companies themselves had to build up their own quality control structures, and the work of the project personnel was to assist in the implementation of such a system. While the Ministry of Agriculture (Veterinary Services) in fact issues the certificates for exportation, they would transfer this power to SEP if it had the capacity. This capacity, however, lies only in Beira (which is the main export centre), and an arrangement has been made with the Veterinary Service that they will not issue a certificate without an analysis from IIP. In Quelimane, because of the distances involved and because there is only one exporter/buyer, a sampling of shrimp is sent down to Beira for analysis to give confidence to the Provincial Department of Agriculture in their issuance of certificates. In Maputo, the shrimp is analysed by the Veterinary Institute. In view of the small number of exportations in Maputo and the good relations which already exist between the IIP and the Veterinary Service, it was deemed necessary at this time to only strengthen the chemical laboratory to augment export analysis in the area the Veterinary Institute was lacking. This appears to be the most economical way of conducting the process at present, with the SNCQ becoming a central archive. The certificates are only certificates of origin and health, and do not give any indication of sensory quality.

It was early recognized that the joint venture companies operate their own quality control through their partners and no direct assistance from the SNCQ was necessary other than a final sanitary inspection when requested. Thus the project need concentrate only on the national companies which is no more than 20% of the shrimp landings.

It also became apparent that problems with the shrimp industry were of two distinct types, one infrastructural such as poor freezing equipment and conditions of transprt and storage, and the other caused by poor worker practices. Over the first, the Project has very little control, but the other might be corrected through training on new methods devised by the Institute.

Thus, the problem of quality control has two parts: to assist in the settlement of differences between the productive and commercial sectors over their rejections which are caused mainly by infrastructural problems, and to improve export quality which is caused mainly by poor worker practices.

4. RESULTS OBTAINED

Within the objectives of the Project, diverse actions were taken which resulted in the following:

4.1 Evaluation of Quality and Methods to Adopt

(a) Samples were collected and analysed from diverse companies applying the methods of Codex, USA and Cuba to analyse shrimp.

(b) In accordance with the situation of the place and the results obtained, the Codex method was more applicable in the laboratory for the destructive analysis of shrimp.

(c) Preliminary standards for first, second and third quality shrimp for visual (non-destructive) analysis were established (Annex 2).

4.2 Creation of Quality Control Group

(a) In order to acquaint all the structures connected with shrimp from production to exportation, a sectorial meeting was conducted by His Excellency the Secretary of State for Fisheries with the presence of directors, fishermen, external trade, Veterinary Service, etc., at which creation of quality control groups at all levels was defined (1).

(b) At this meeting the national companies guaranteed the creation of these groups in each unit of production.

(c) Groups were created in Emopesca - Beira, Quelimane, Angoche and also in the canning factory and drying yards in Maputo and personnel were trained, in their appropriate location, to constitute these groups.

4.3 Laboratory and Inspection Stations

(a) The fish inspection laboratory in Beira (the principal) is now installed and is functioning in all sections of microbiology, chemistry and inspection (organoleptic analysis) (2).

(b) The laboratory in Maputo is being equipped to do principally chemical analyses to augment expert analyses in areas in which the Veterinary Institute was lacking and to give assistance to the local processing sector in their own quality control programme.

(c) The fish inspection stations in Quelimane and Angoche are not yet set up because of lack of trained personnel to guarantee their functions.

4.4 Professional Training Connected to the Project

(a) Practical, on-the-job training, and theoretical training of project staff by international personnel.

(b) International training courses such as FAO/DANIDA Course on Fish Technology and Quality Control in Angola, in which five elements of the SNCQ participated and two from industry.

(c) A series of short training courses for industry of approximately one week duration given mainly by local staff.

(d) A national training course for the most promising of the students from the short courses with the participation of 24 trainees and 10 monitors.

(e) Elaboration of training documents and instructional manuals (3).

4.5 Processing of Shrimp on Board

(a) A preliminary assessment of the problem of incorrect practices for handling shrimp on board with the difficult conditions of equipment was made and a preliminary code of practice elaborated.

(b) A consultancy from FAO further identified various problems of organizational and material conditions which do not permit correct practices on board and certain modifications were suggested.

(c) A standard (code of practice) was elaborated (Annex III), as well as a manual of handling on board the boats (3).

4.6 Standards Elaborated

Provisionally the following standards have been elaborated:

- Standard for processing canned fish
- Standard for processing dried and salted fish
- Standard of quality for dried and salted fish
- Standard for processing of smoked fish
- Standard of quality for smoked fish
- Standard of inspection of smoked fish

4.7 Work in the Commercial Sector

(a) With the separation of the productive and commercial sectors in different Ministries, there is an internal sale whereby the commercial sector operates its own system of quality control (100% end-of-line product inspection), and for the most part shrimp affected by "melanosis" or black spot, alteration of colour, etc., which is visible, is rejected for direct exportation. This end-of-line inspection, however, cannot detect subtle difficulties of classification and this is in fact the main export problem which is borne out by buyer complaints. The efficiency of this verification process in relation to Codex is given in Annex 4.

(b) Recently, export results are being linked with the productive sector. A new contract has been set up between the national companies and the commercial sector whereby the national companies will receive a percentage of the export price to cover operating costs. A quality factor, which includes price differentials, has been inserted into the contract.

(c) The part of the contract referring to classification has been defined in such a way that it will diminish the number of poorly graded blocks being exported, thus raising the confidence of the buyers. This is of course a "stopgap" solution, but necessary at this time.

5. CONCLUSIONS AND PERSPECTIVES

A national quality control system has been created within the IIP and is functioning adequately. Quality control groups have been created in all national companies. Technical staff have received intensive training and have given a number of courses to low-level workers within the quality control groups or fishermen. A number of standards, guidelines and manuals have been prepared.

Due to infrastructural problems, the quality of Emopesca's shrimp, which is traded internally between the productive and commercial sectors, is not likely to improve in the short run. However, when the new freezing plant in Beira and Quelimane start operating correctly it is expected that quality will improve. Regarding export quality, with the new guidelines on classification being effective since mid-1984, it is expected that there will be fewer buyers' complaints regarding classification and that buyers' confidence in Mozambican shrimp should rise. Given the ongoing programme for handling at sea, in the long run there should be an improvement of classification on board. The mode of operation of the IIP is demonstrated in Annex 5.

6. REFERENCES

(1) Document of the sectorial meeting of quality control in shrimp, Department of Fish Technology, Maputo (not published)

(2) Methods of microbiological analysis for the Laboratory of Fish Inspection. L.G. Limpus, Zé Miguel (not published)

(3) Documents presented in the National Training Course on Fish Technology and Quality Control, Maputo, September/October 1984:

- Compendium of Technology and Quality Control of Fish
- Manual of Production of Fish Silage
- Manual of production of smoked fish
- Manual of production of dried and salted fish
- Manual of handling and quality control of shrimp aboard
- Manual of shrimp quality control after landing
- Manual of handling fish on board
- Manual of fish quality control

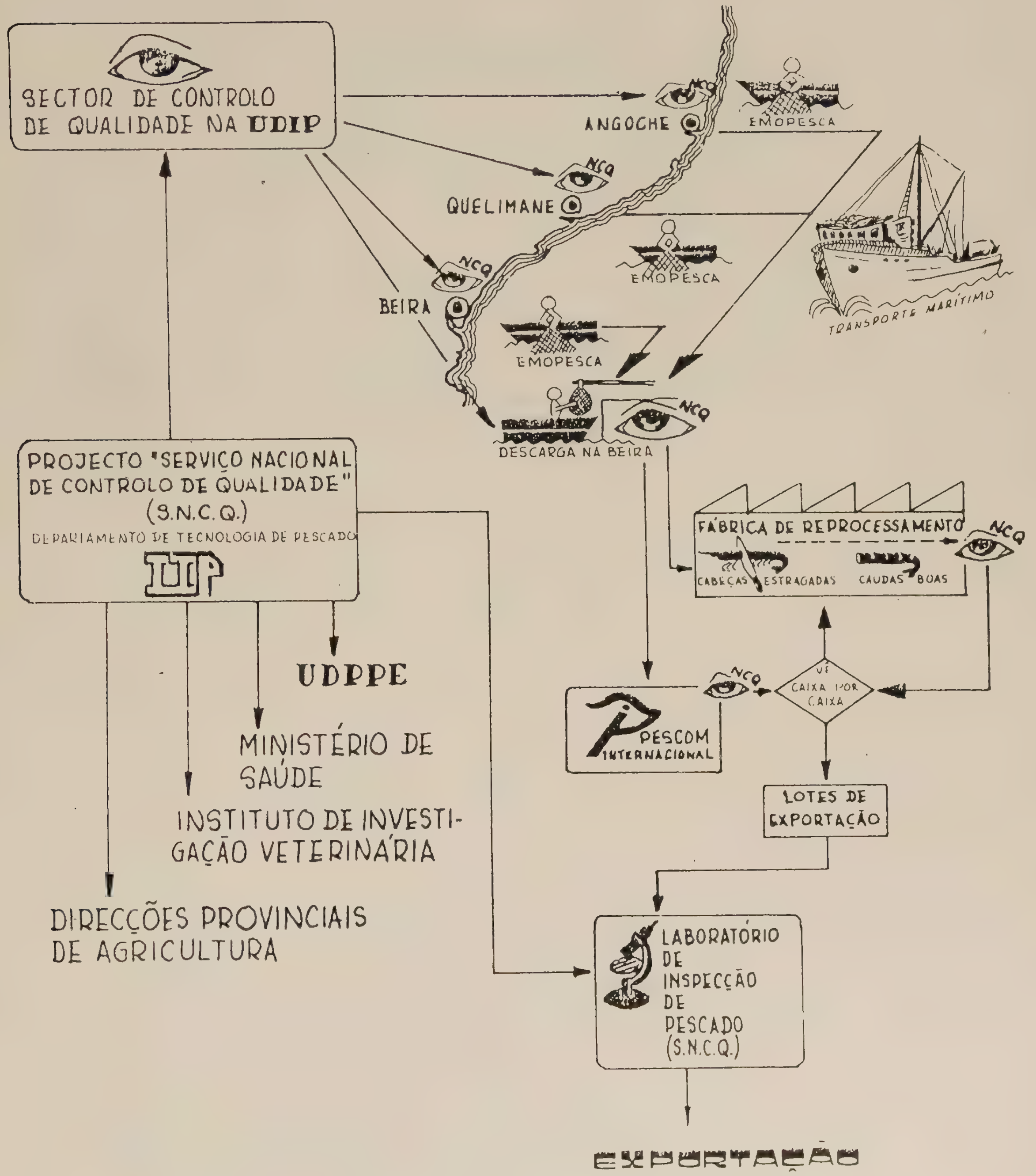
(4) Preliminary report of the consultancy about landing of shrimp on board. C. Steck (not published)

(5) Some results of the work of the project for the mounting of a National Quality Control System. L.G. Limpus, Salita Chringja, Isabel Goncalves (not published)

(6) Documentation of the chemical treatment of shrimp. L. Arthur, H. Pelgrom, E. Casadei, T. Chissaque (not published)

ANNEX 1

FLUXO (ESQUEMA) DA ORGANIZAÇÃO DA ENTREGA DO PRODUTO E DA LOCALIZAÇÃO DOS "NÚCLEOS DE CONTROLO DE QUALIDADE" DAS EMPRESAS E DO PROJECTO "Sistema Nacional de Controlo de Qualidade"


SECTOR DE CONTROLO DE QUALIDADE NA UDIP
NCQ
ANGOCHE
EMOPESCA
NCQ
QUELIMANE
NCQ
BEIRA
EMOPESCA
EMOPESCA
TRANSPORTE MARÍTIMO
NCQ
DESCARGA NA BEIRA
PROJECTO "SERVIÇO NACIONAL DE CONTROLO DE QUALIDADE" (S.N.C.Q.)
DEPARTAMENTO DE TECNOLOGIA DE PESCADO
UIP
FÁBRICA DE REPROCESSAMENTO
NCQ
CABEÇAS ESTRAGADAS
CAUDAS BOAS
UDPPE
MINISTÉRIO DE SAÚDE
INSTITUTO DE INVESTIGAÇÃO VETERINÁRIA
DIRECÇÕES PROVINCIAIS DE AGRICULTURA
NCQ
PESCOM INTERNACIONAL
VÊ CAIXA POR CAIXA
LOTES DE EXPORTAÇÃO
LABORATÓRIO DE INSPECÇÃO DE PESCADO (S.N.C.Q.)
EXPORTAÇÃO

ANNEX 2

Grades of Quality for Shrimp

First quality - Shrimp without defects, odour and colour characteristics and well packed

Second quality - The shrimp may have some dehydration or a little alteration of colour (slightly yellow), or present an aspect of freezing and thawing

Third quality - The shrimp has blacking or significant alteration of colour (reddening), or is damaged

Table of grades of quality in a visual analysis
of the product not thawed

Defect/Percentage	First quality	Second quality	Third quality
Black - spot			
Alteration of colour			
Classification			
Other defects			

ANNEX 3

(Taken from original as it is written in portuguese)

D. Tecn. Pescado (S.N.C.Q.) do IIP	Norma de manipulação de camarão Congelado inteiro nos barcos (Norma de processamento)	Jan/1984

1. Objectivo: Esta norma estabelece os requisitos minimos de manipulação do camarão congelado inteiro nos barcos

2. Âmbito de aplicação: Esta norma destina-se essencialmente a ser aplicada nos barcos do tipo das " Empresas Emopesca " da Unidade de Direcção da Pesca Industrial

3. Descrição do Produto:

3.1 Matéria-prima

Utilizam-se os camarões das espécies:

Penaeus monodon – camarão tigre ou jumbo
Penaeus indicus – camarão branco
Metapenaeus monoceros – camarão castanho
Penaeus latisulcatos – camarão marfim
Penaeus japonicus – camarão flor

3.2 Qualidade de matéria-prima

Os camarões congelados devem ser elaborados de camarões frescos, crus e limpos; com qualidade para consumo humano

4. Processamento

4.1 Captura

a) Os arrastos não podem durar mais que quatro horas
b) Se a rede estiver demasiado cheia após três horas o arrasto deve terminar

4.2 Recepção

a) O convés onde se descarrega o camarão deve estar limpo (sem óleo, restos de peixe, etc.) e protegido do sol (por ex. com uma lona).
b) Deve evitar-se pisar o camarão e restantes produtos da captura
c) A rede deve ser aberta perto do solo para se evitar danificar o camarão

4.3 Classificação

1° Nos barcos em que não existe mesa grande de processamento

a) O saco da rede é aberto o mais próximo possivel do chão
b) Em cada uma das pilhas de camarão (são duas) são colocadas quatro caixas plásticas

Em cima da pilha numa das caixas coloca-se camarão TG e TM
noutra caixa coloca-se camarão K
noutra caixa coloca-se camarão Q
noutra caixa coloca-se camarão S e SS

c) Entre as pernas de cada marinheiro é colocada uma bacia pequena para o camarão SSS

d) Ao lado da pilha são colocadas duas caixas para peixe de 2° e 3° categoria

2° Nos barcos que têm mesa grande de processamento

a) A captura dos sacos das duas redes é colocada directamente na mesa ou posta em cima desta com uma pá

b) De cada lado da mesa colocam-se três marinheiros

c) Atrás de cada grupo de três marinheiros são colocadas sete caixas de plástico para cada calibre de camarão e duas para o peixe de 2° e 3° categoria

d) Colocada parcialmente debaixo da mesa são postas caixas para as matérias da Fauna Acompanhante que vão ser deitadas ao mar

3° Para ambos os tipos de barco:

a) O máximo de camarão que se coloca nas caixas de camarão são 10 Kg e nunca mais.

b) Os camarões que não tenham tamanho ou apresentem defeitos não devem ser classificados e são colocados numa caixa diferente

4.4 Lavagem

a) O camarão (10 Kg) colocado nas caixas deve ser lavado de forma a ficar livre de sujidade, restos de algas, areia, etc.

b) Cada caixa deve ser inspeccionada antes do tratamento quimico e se for detectada alguma sujidade deve haver uma nova lavagem

4.5 Tratamento quimico

a) Para o tratamento quimico do camarão utiliza-se uma solução composta de água, metabisulfito de sódio e de ácido citrico

b) A solução prepara-se dissolvendo 1 saco de metabisulfito de sódio (1,5 Kg) e um saco de ácido citrico (200 g) em 100 litros de água do mar limpa e agitando muito bem, de forma a dissolver todo o contéudo dos sacos

c) Para cada 100 litros de solução (preparada segundo o ponto b) só se pode mergulhar 100 Kg de camarão para o tratamento quimico. O tecnologo é a pessoa responsável pelo controle

d) Quando houver um arrasto de mais que 100 Kg de camarão, o Tecnologo (que é a pessoa responsável por esta tarefa) deverá preparar mais solução

e) A duração do tratamento quimico é de cinco minutos

f) Dependendo das dimensões do tanque colocam-se uma ou mais caixas com 10 Kg de camarão para tratamento quimico, umas em cima das outras ou uma de cada lado. O importante é que se devem colocar as caixas ao mesmo tempo para serem retiradas também ao mesmo tempo.

4.6 Embalagem

a) As caixas plásticas com camarão bem classificado devem ser colocadas em cima da mesa de embalagem, duas de cada vez (cada uma com 10 Kg) e começando-se pelos calibres em maior quantidade naquele arrasto.

b) Antes de se colocar o camarão, deve ser posta na caixa de 2 Kg uma folha de polietileno (folha de plástico).

c) Ao colocar-se o camarão nas caixas de 2 Kg, deve ter-se o cuidado de se retirar todos os camarões que por acaso ainda se apresentem fora do calibre que no momento está a ser embalado.

d) O camarão deve ser arrumado nas caixas conforme o definido pela empresa, mas de forma a que se apresente com uma aparência agradável.

e) O camarão que não pertence a nenhum calibre comercializável no mercado internacional (SSSS e muda) deve ser colocado em sacos de plástico de 5 Kg e congelado.

4.7 Congelação

a) Colocamos as caixas marcadas e inspeccionadas na posição invertida nos tabuleiros que vão para as câmaras de congelação.

b) Os tempos de congelação dependem da temperatura da câmara de congelação, ou seja:

Temperatura	Tempo
- 40° C	5 horas
- 35° C	6 horas
- 30° C	8 horas
- 25° C	11 horas
- 20° C	(o barco deve regressar para reparação)

4.8 Armazenamento

a) O produto deve ser colocado em câmaras de conservação, após ser embalado em master-cartons devidamente marcados.

b) A temperatura do porão deve ser controlada duas vezes por dia

c) O camarão é armazenado em lugar separado do peixe.

d) Para mais connecimento devem consultar as normas de armazenagem em câmaras de conservação.

4.9 Descarga

a) Esta operação deve ser o mais rapida possivel

b) O tecnologo deve entregar ao N.C. Qualidade as ocorrências mais importantes que possam ter afectado a qualidade do lote, e participar no controle de qualidade do produto.

ANNEX 4

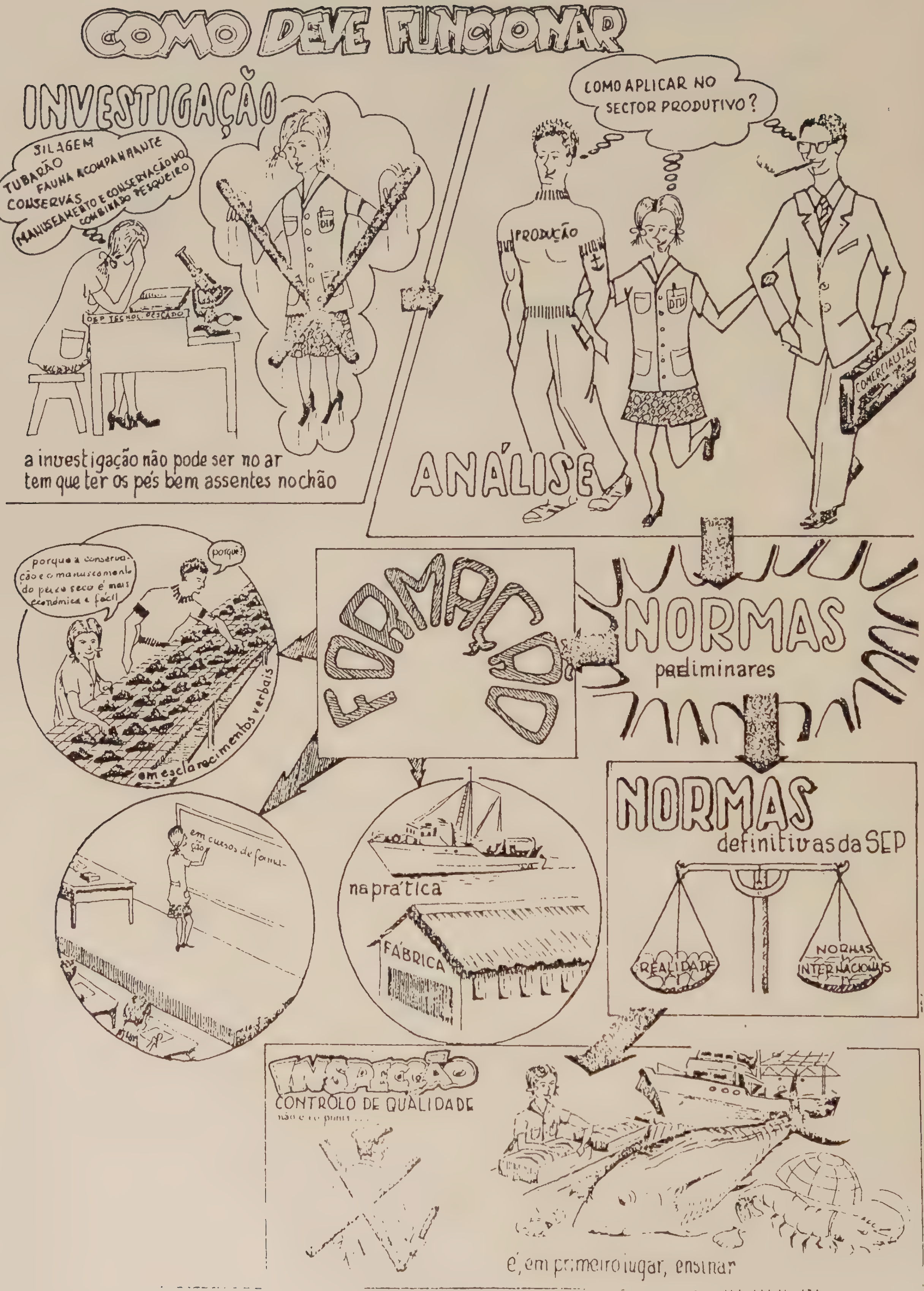
Lots exported by Pescom Internacional, and their defects in relation to Codex Alimentarius

Lot No.	Aspect		Classification	
	within limit	outside limit	within limit	outside limit
4	17	5[a]	16 (73%)	6 (27%)
5	34	4	25 (66%)	13 (34)
6	53	16[a]	37 (53)	32 (47)
7	20	4[a]	12 (50)	12 (50)
8	27	11[a]	20 (53)	18 (47)
9	13	2	9 (60)	6 (40)
10	33	6	22 (56)	17 (44)

[a] Lots rejected for appearance with respect to Codex sampling plan AQL 6.5

Classification is defined as outside limit when more than 20% of the shrimp is within a different category

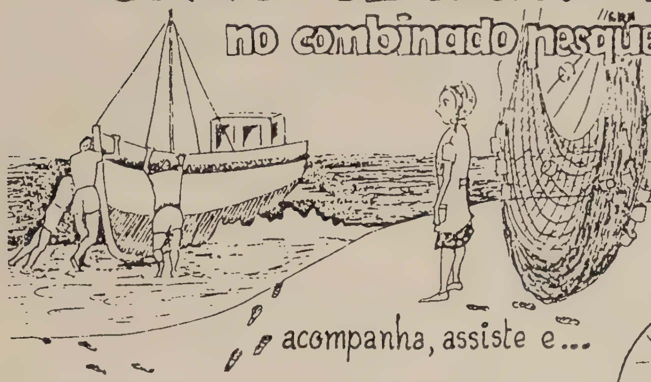
ANNEX 5


COMO DEVE FUNCIONAR
INVESTIGAÇÃO
SILAGEM
TUBARÃO
FAUNA ACOMPANHANTE
CONSERVAS
MANUSEAMENTO E CONSERVAÇÃO NO COMBINADO PESQUEIRO
DEP TECNOL PESCADO
DIU
a investigação não pode ser no ar
tem que ter os pés bem assentes no chão
COMO APLICAR NO SECTOR PRODUTIVO?
PRODUÇÃO
DIU
COMERCIALIZAÇÃO
ANÁLISE
porque a conservação e o manuseamento do peixe seco é mais económica e fácil
porquê?
em esclarecimentos verbais
FORMAÇÃO
NORMAS
preliminares
em cursos de formação
na prática
FÁBRICA
NORMAS
definitivas da SEP
REALIDADE
NORMAS INTERNACIONAIS
INSPECÇÃO
CONTROLO DE QUALIDADE
não é só punir ...
é, em primeiro lugar, ensinar

DEPARTAMENTO DE TECNOLOGIA DE PESCADO

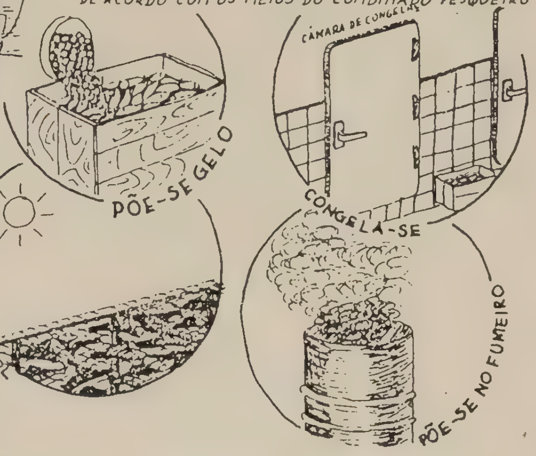
COMO SE INSERE NA PRODUÇÃO II

no combinado pesqueiro



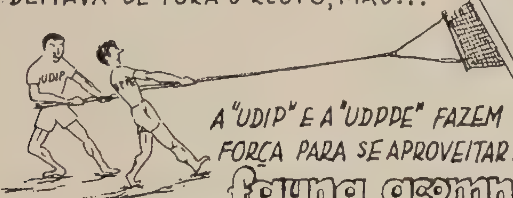
...discute e ensina

COMO MANUSEAR O PESCADO E COMO CONSERVÁ-LO DE ACORDO COM OS MEIOS DO COMBINADO PESQUEIRO


CÂMARA DE CONGELAÇÃO
PÕE-SE GELO
CONGELA-SE
SECA-SE AO SOL
PÕE-SE NO FUMEIRO

acompanha, assiste e...

ANTES, SÓ SE APROVEITAVA O CAMARÃO E DEITAVA-SE FORA O RESTO, MAS...

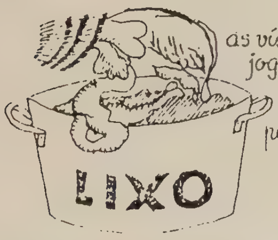


A "UDIP" E A "UDPPE" FAZEM FORÇA PARA SE APROVEITAR A

fauna acompanhante

o D.T.P. investiga a forma rentável de conservar e aproveitar essa fauna

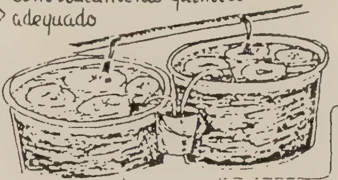
projecto silagem



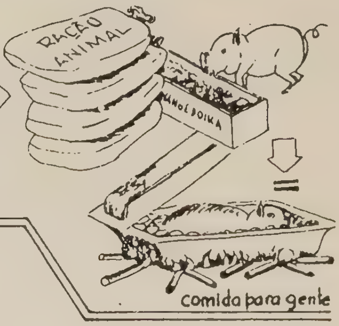
as vísceras eram jogadas no lixo

porém

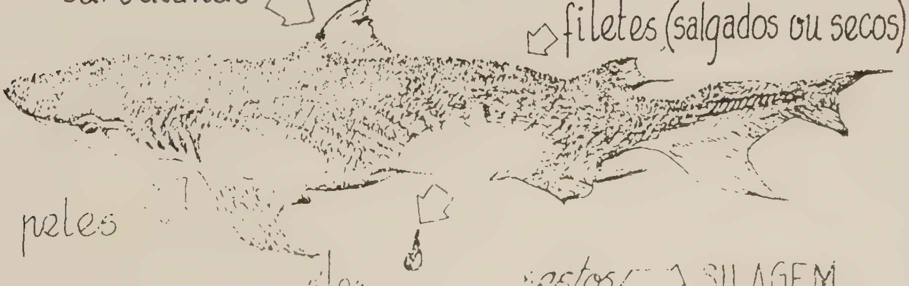
com tratamento químico adequado



teremos


RAÇÃO ANIMAL
MANJEDOIRA
comida para gente

tubarão rei dos peixes


barbatanas
filetes (salgados ou secos)
peles

dos restos [illegible] SILAGEM

A SURVEY OF HISTAMINE LEVELS IN COMMERCIALLY PROCESSED FISH IN MOROCCO

by

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ABSTRACT

A method for histamine determination in fish products was developed and tested. It consists of extraction of histamine by 10% trichloroacetic acid, separation through a chromatographic column using a cationic exchange resin (Amberlite CG50, 100-200 mesh), elution by 0.2N HCl, complexation with a 1% orthophthaladehyde (OPT) solution in methanol, and then quantification by spectrofluorimetry using 360 nm and 450 nm for the excitation and emission wavelengths, respectively.

An elution volume of 20 ml 0.2N HCl was necessary to obtain recovery rates of 96% or above. The resin exchange capacity was 0.172 mg histamine/g of resin, equivalent to 774 mg histamine/100 g of fish (mg%). The complex OPT/histamine was found to be stable only for 30 min. The instrument linearity response ranged from 0.0288 mg% (which is the lower limit of sensitivity) to 72 mg%.

This method was used to determine histamine levels in 248 commercially processed samples of fish. Concentrations ranging from 0 mg% to 694 mg% were observed. The mean was 12.33 mg% and the standard deviation was 55.28 mg%. The bulk of the samples had low histamine levels with 85.5% of the samples having less than 10 mg%. Twenty-six samples (10.5%) had levels within the 10-50 mg% range and should be classified as not from fresh fish or low quality. Ten samples (4%) had toxicologically significant levels, above 50 mg%.

Tuna fish was more susceptible to histamine development than sardines or mackerel. Seven percent of tuna fish samples contained levels above 50 mg%, as compared to 3.7% and 3.2% for sardines and mackerel, respectively. The percentage of samples containing levels above 50 mg% was somewhat higher for fish processed in the central region (7.1%) than the southern (4.3%) or northern (1.3%) regions, suggesting more mishandling of fish processed in the centre. The average concentration of samples with levels above 50 mg% was much higher for fish processed during the high fishing seasons (232.5 mg%) than during the low season (142.0 mg%), suggesting storage at ambient temperature for long periods of time in the first case.

Histamine development in "fresh" sardines was studied as a function of time and for different temperatures and salt contents. The data indicated a first order reaction kinetics. Reaction rates varied from 0.00178/min to 0.000421/min. Refrigeration was very efficient for controlling histamine development. Fish held at 8°C showed a shelf life 12 h longer than fish held at 17°C. The combination salting-refrigeration was the most efficient. Fish held at 8°C and salted at a level of 5% or 8% showed a shelf life of 35 h longer than fish held at 17°C with no salt.

1. INTRODUCTION

The agricultural and fisheries sectors are important to the Moroccan economy and account for about 30% of Morocco's Gross Domestic Product (Folsom, 1977).

Morocco's fishermen, who operate both in the Atlantic Ocean and in the Mediterranean Sea (Figure 1), landed nearly 440 000 t of fishery products in 1983 (Maroc, Office National des Pêches, 1983). Sardines play a leading role as they have for years and account for about 75% to over 95% of all landings (Tourvieille, 1974; Folsom, 1977a; Maroc, Office National des Pêches, 1983).

A major development in 1976 affecting Morocco's fisheries was the opening of the waters off the ex-Spanish Sahara to Moroccan fishermen. These new fishing grounds are believed to contain 1.7 million tons of sardines - three times the amount found in Morocco's traditional fishing grounds. This new resource could make Morocco one of the biggest sardine producers in the world (Folsom, 1977). Fifty-sixty percent of the total catch is used to produce fishmeal. About 30% is used for canning, 5-15% is sold locally as fresh fish and the rest is frozen or is otherwise processed (Tourvieille, 1974; Folsom, 1977).

Morocco's fish products enjoy worldwide sales. They are exported to an average of 100 nations around the world (Folsom, 1977). However, export figures have fallen steadily during the last decade, particularly to the European Economic Community market which bought only 35-37% of the Moroccan exportation in 1983 as compared to 45-50% in 1982. Several factors, as reviewed earlier by Folsom (1977a), have been evoked to explain this situation. Moreover, importers and public health officers from the European Economic Community have expressed dissatisfaction regarding the wholesomeness of Moroccan canned fish which they think could be due to poor handling and processing in outdated plants. These complaints came after several outbreaks of food poisoning occurred in Europe, implicating Moroccan fish products. For example, Murray, Hobbs and Gilbert (1982) conducted an investigation in the United Kingdom on 26 incidents of scombrotoxin poisoning that involved 71 people, and found that the highest rate of incidents (7 incidents involving 41 people, with at least 69 at risk), observed after the consumption of Moroccan sardines (Table 1).

Table 1

Scombrotoxin poisoning from canned fish in the United Kingdom
March 1979 - March 1981

Country	Incident number	Number of persons ill	Number of persons at risk
Morocco	7	41	69[a]
United Kingdom	4	7	2[b]
Taiwan	4	6	6[a]
Japan	3	4	4
Thailand	2	2	2
Peru	1	4	4
Malaysia	1	2	2
Philippines	1	2	2
Fiji	1	1	1
Solomon Islands	1	1	1
Spain	1	1	1
Total	26	71	94

Source: Murray, Hobbs and Gilbert (1982)

a/ In one incident with one person ill, the number of persons at risk was not reported

b/ In two incidents with one and four persons ill, respectively, the number of persons at risk was not reported

Scombrotoxin poisoning generally results from the ingestion of fish of the families Scomberesocidae and Scombridae, which include tuna, bonito and mackerel. Onset of the poisoning symptoms ranges from a few minutes to two hours after eating. The toxic food, as consumed, may have a sharp, peppery flavour and invariably contains high levels of histamine (Arnold and Brown, 1978). Victims generally experience a flushing of the face and neck, a throbbing headache, dizziness, faintness and an itching, burning sensation in the mouth and throat. Cardiac palpitations may occur (Nerisson, 1976).

Secondary symptoms are gastrointestinal in nature and include abdominal cramps, nausea without vomiting and diarrhoea. In severe cases, suffocation and respiratory distress have been reported (Arnold and Brown, 1978; Murray, Hobbs and Gilbert, 1982).

Consequently, there was an urgent need to investigate the histamine problem in Moroccan fishery products in order to compile data on the conditions that lead to the accumulation of this toxin and to develop efficient preventive measures.

The objectives of the present work consisted of:

- developing a reliable method for the determination of histamine in fish products,
- conducting a survey on histamine levels in commercially processed fish in Morocco, and
- studying the effects of temperature and salt concentration on histamine production in Moroccan sardines.

2. MATERIALS AND METHODS

2.1 Histamine Determination

Histamine determinations were carried out using the method of Lerke and Bell (1976), which is the official method in France. Minor changes were made and will be discussed.

Samples: Samples of canned tuna, sardines or mackerel were prepared by blending 10 g of the well mixed can contents in an electric mixer with 90 ml of 10% trichloroacetic acid (TCA) solution for 1-2 min. The homogenate was then filtered through filter paper.

Standards: 0.10 g of histamine (free base)(Sigma Chemical Company) was dissolved in 100 ml of 0.2N HCl (or 10% TCA). This solution was equivalent to 100 mg of histamine-free base/100 g (100 mg%); 2 ml of this solution were transferred to a 100 ml volumetric flask and the volume made up to the mark with 10% TCA (or 0.2N HCl). This 2 mg% histamine solution was stable in the refrigerator for several weeks and was used to prepare further diluted solutions as needed.

Ion exchange column: 150 x 10 mm (i.d.) chromatographic columns were made at the Institut agronomique et vétérinaire Hassan II, Rabat, and were fitted with a 50-ml reservoir at the top and tygon tubing at the bottom. Glass wool was used at the bottom of the column to hold the resin and a Mohr's holder was used as a stopper. Acetate buffer (pH 4.62) was prepared by mixing 29.4 g of sodium acetate (CH_3 COONa, 3 H_2O) and 11 ml of glacial acetic acid in a small amount of water and diluting to 2.0 litres. The pH was adjusted to 4.62 with glacial acetic acid; 20 ml of this acetate buffer was poured into the chromatographic column. One gramme of cationic exchange resin (Amberlite CG-50, type 1, 100-200 mesh) was then placed in the column and the acetate buffer was allowed to drip to a level slightly above the resin.

Separation of histamine: 0.2 ml of the extract (or its diluted equivalent) were transferred to a 100-ml flask and 20.0 ml of pH 4.62 acetate buffer was added. The mixture was then transferred onto the column, previously conditioned as described above; 30 ml of acetate buffer was used to rinse the flask in order to achieve quantitative sample transfer. After all dripping had stopped, the column was washed with about 100 ml of acetate buffer and the washing discarded. The retained histamine was eluted with 20 ml of 0.2N HCl. The elution flow rate was unrestricted and was determined by the physical parameters of the column.

Determination of histamine: 2.0 ml of the above eluate were transferred to another test tube and, in succession, were added 1.0 ml of 1N NaOH and 0.1 ml of a 1% orthophthalaldehyde (OPT) in methanol; 3.5 min after addition of OPT, the solution was acidified with 2.0 ml of 0.7N HCl. The resultant fluorescence was read on a Shimadzu Spectrofluorophotometer RF510 with emission and excitation wavelength of 450 nm and 360 nm, respectively. The blank consisted of 2.0 ml of distilled water instead of eluate, while the external histamine standard used 2.0 ml of a solution containing 0.0002 mg/ml of 0.2N HCl. All conditions, especially temperature, were as close as possible for standards and sample.

Calculations: Under the above conditions, histamine contents in milligrammes of histamine per 100 g of sample (mg%) were calculated from comparison of the fluorescence intensities of the sample and the external histamine standard after correction for the fluorescence intensity of the blank:

$$\text{mg\%} = \frac{\text{sample fluorescence intensity} - \text{blank fluorescence intensity}}{\text{standard fluorescence intensity} - \text{blank fluorescence intensity}} \times 18$$

These calculations were based on a final fish equivalent of 1/450 g in the sample on which fluorescence was measured, and final histamine content of 0.0004 g in the external standard.

Lower limit of detection and linearity of instrument response: The standard solution (2 mg%) of histamine in 0.2N HCl was used to prepare diluted solutions containing concentrations up to 2.5×10^{-3} mg of histamine/millilitre of 0.2N HCl (equivalent to 225 mg histamine/100 g of fish). Two millilitres of each of these solutions were complexed with OPT and fluorescence was read as described above. The blank consisted of 2 ml of 0.2N HCl. The lower limit of sensitivity and the instrument linearity were determined from the standard curve of histamine concentration versus fluorescence intensity. This experiment was conducted twice.

- Stability of the histamine - OPT complex: 20 ml of a standard solution containing 2 x 10^{-4} mg histamine/millilitre of HCl 0.2N were prepared and complexed with OPT as described above. Samples were then drawn during two hours at predetermined time intervals and fluorescence was read. This experiment was carried out twice.

Ion exchange capacity: Histamine separation was carried out as described above on 10 ml of a standard solution containing 2 mg of histamine/100 ml of 10% TCA. However, the retained histamine was eluted with 60 ml of 0.2N HCl instead of 20 ml and the eluate was collected in fractions of 10 ml each. Histamine determination was then conducted on 2 ml of each fraction as described above.

Histamine recovery rate: Using 0.2 ml of a standard solution containing 2 mg of histamine per 100 ml of 10% TCA, histamine separation and determination were carried out as described above, and compared against external histamine standards that had been added to blank column eluates, to determine recovery.

Histamine recovery was also studied in parallel from extracts of canned sardines. Two samples (10 g each) were drawn from a well mixed can content. Histamine extraction was conducted with 90 ml of 10% TCA for one sample and with 90 ml of the standard solution of histamine in 10% TCA (2 mg%) for the other. Separations and comparisons were carried out as before, and compared against the external standards.

Confirmation of column separation using thin layer chromatography (TLC): Samples of canned tuna, sardines and mackerel, known to contain histamine, were prepared and submitted to extraction, separation and complexation as described above. An external histamine standard (0.002 mg histamine per millilitre of 0.2N HCl) was also prepared. Ten microlitres were drawn from each solution (samples and standard) and applied to plates coated with silica gel G60. The spots were allowed to air-dry before placing the plates in the developing chamber. The TLC plates were developed using a chloroform-methanol-conc. ammonia system (2:2:1) or a n-butanol-acetone-water (2:2:1) system (Lieber and Taylor, 1978). Spots were visualized with a ninhydrin spray containing 300 mg ninhydrin in 100-ml n-butanol to which 3 ml of glacial acetic acid were added. Histamine separation was also studied by applying to the TLC plates eluates that had already been mixed with OPT. Three solvent systems were then used for development: chloroform-methanol-conc. ammonia (2:2:1), n-butanol-acetone-water (2:2:1) and chloroform-methanol-conc. ammonia (12:7:1). Spots were visualized using a U.V. lamp (366 nm).

2.2 Survey of Histamine Levels in Canned Fish - Experimental Design

Two hundred and forty-eight samples of fish were obtained from retail markets in the Rabat-Sale and Casablanca areas. They were stored in the refrigerator and opened immediately before analysis. All the samples had been canned and thermally processed. The sampling procedure was carried out using a factorial design (2 x 3 x 3). The factors studied were:

- the region where the fish was processed (identified by the code number on the can). Figure 1 represents the three regions studied as well as the average annual temperature and salt concentration in the surrounding waters;
- the fish variety: sardines, mackerel or tuna;
- the fishing season (high or low season), identified by the processing date on the can. The Moroccan canneries have generally a small processing capacity (15-20 t/day). Consequently, during the high fishing season, the fish is stored at ambient temperature for some time until it can be processed. The high fishing season is from August to October for sardines, and July through October for tuna and mackerel, while the low fishing season is from December to August for sardines and tuna, and December through June for mackerel (Folsom, 1977).

These factors were felt to be the most influential with regard to the fish susceptibility to histamine production. Table 2 shows the distribution of the 248 samples according to this design.

Sample preparation, histamine extraction, separation and determination were carried out as described above. In addition, 10-15 g of the well mixed content of each can were also drawn and stored in the freezer for further confirmatory tests. When a high content of histamine was found, this frozen sample was used to confirm the result.

2.3 Effect of Storage Temperature and Salt Concentration on Histamine Development in Sardines

Fifteen kilogrammes of sardines were bought at the fish market of Casablance and transported in ice box to the laboratory. They were then equally divided into nine lots. One lot was immediately stored in the freezer at -18°C. The other lots were sprinkled with salt at concentrations of 0 g,

Table 2

Distribution of samples according to the 2 x 3 x 3 factorial design

Fishing season	Sardines			Mackerel			Tuna		
	North	Centre	South	North	Centre	South	North	Centre	South
High	8	24	10	11	16	23	19	9	0
Low	6	11	23	13	19	13	23	20	0

2 g, 5 g and 8 g of salt/100 g of fish. For each salt concentration, one lot was stored at ambient temperature and another at 10°C. From each lot, a sample of three fish was drawn randomly at predetermined intervals of time and well mixed. Then, sample preparation, histamine separation and determination were carried out as described before. Assuming zero order or first order kinetics for histamine production versus time, a linear model was fitted to the data using the least squares analysis (Snedecor and Cochran, 1980). This experiment was conducted three times. For one experiment, a temperature of 8°C was used instead of 10°C.

3. RESULTS AND DISCUSSION

The analysis of histamine first required the development of a technique. Evaluation of existing methodology allowed us to choose a method based on a combination of extraction, purification and detection techniques that were modified and adapted to our available resources so as to provide optimum speed, accuracy and reproducibility.

Using the standard curve of histamine concentration versus relative fluorescence intensity, the lower limit of detection (LLD) and the instrument linearity response were determined. An LLD of 6.4 mg (or 0.057 nmoles) in the standard, equivalent to 0.288 mg/100 g of fish (mg%) was found. This limit is slightly above the value reported by Taylor and Lieber (1977) who found 0.05 nmoles using the fluorimetric method of Shore (1971), but much lower than the level of 50 nmoles reported for a spectrophotometric method (Taylor and Lieber, 1977). This result shows the high sensitivity of the fluorimetric methods.

The fluorimeter response was linear throughout the range of 0.288 - 72 mg%. Correlation coefficients of 0.98 and 0.99 were obtained. Therefore samples with histamine content above 72 mg% were diluted to levels within the linear range.

Fluorescence intensity of the OPT-histamine complex was stable for 30 min, then started to decrease, reaching a loss of 6.7% and 8.3% after one and two hours, respectively. Therefore, for all histamine determinations, fluorescence was read within 30 min after the addition of 0.7N HCl. The ion exchange rate was 0.172 mg histamine/gramme of resin equivalent to 774 mg%.

We also determined recoveries for twelve columns, on standards diluted in 10% TCA and extracts of fish to which histamine was added. Recovery rates varied from one column to the other and averaged from 45% to 97.2%. Columns with the lowest recoveries were found to have an internal diameter (I.D.) of 12 mm, different from our original specification. These columns were discarded and replaced. The 10-mm I.D. columns showed recovery rates that were higher (85% and above), but still below the values of 99.7-100.4% reported by Lerke and Bell (1976). Further improvement was accomplished through increase of the elution volume. Indeed, eluting with 30 ml of 0.2N HCl and reading fluorescence on each 2 ml fraction of the eluate after complexation with OPT, we found that the 13th fraction (corresponding to an elution volume of 26 ml) had an intensity equal to that of the blank. The total intensity after the 12th fraction was from 5.7% to 10.7% higher than the total intensity after the 9th fraction. Therefore, a complete recovery of histamine from the resin required elution with 24 ml of 0.2N HCl. However, this would have increased the LLD from 0.288 mg% to 0.288 x 24:18 = 0.384 mg%, thus affecting accuracy for samples with low levels of histamine. Therefore, it was felt that the use of a lower elution volume was more appropriate. With 20 ml of 0.2N HCl, recovery rates averaged 96-97% and accuracy was not affected. This elution volume was therefore adopted, and the recovery checked routinely.

We further confirmed histamine separation on thin layer chromatograms of eluates from a standard and samples of tuna, mackerel and sardines. After visualizing with ninhydrin, only the histamine spot developed with both solvent systems (chloroform-methanol-conc. ammonia, 2:2:1 and n-butanol-acetone-water, 2:2:1). An Rf of 0.81 was obtained with the first solvent system and compared favourably to 0.79 reported by Taylor and Lieber (1977). This indicated that no other amines which react with ninhydrin were extracted and separated through the column. This, however, does not exclude the possibility that some other OPT specific substances were present. This eventuality was ruled out by preparing TL chromatograms of OPT-treated eluates and visualizing the spots under a U.V. lamp (366 nm). Under these conditions only the histamine spot developed and showed an Rf of 0.45 with the solvent system chloroform-methanol-conc. ammonia (2:2:1), 0.79 with the system n-butanol-acetone-water (2:2:1) and 0.69 for the system chloroform-methanol-conc. ammonia (12:7:1). These results confirmed the completeness of histamine separation through the column.

Once the technique was developed and tested, a survey of histamine levels in 248 cans of fish was conducted. The data are presented in Table 3 using a stem and leaf display (Tukey, 1977). The combination of stem and leaves in the second line for example represents the following histamine levels (in mg%): 0.14, 0.17, 0.19, etc. Similarly, the data in the 19th line should be read (in mg%): 10.1, 10.9, 11.50, 11.70 and so on. The first column marked "depth" represents the number of leaves (i.e., values) accumulated from the top and bottom, except for one of the values (17) in the middle, which is the number of leaves at that stem. These data show that histamine levels in Moroccan canned fish ranged from 0 mg% to 694 mg% with a mean of 12.33 mg% and a standard deviation of 55.28 mg%. Quevauviller and Van Hoa (1965) reported somewhat lower histamine concentrations in France, <1 mg% in general with a maximum of 3.3 mg%. Taylor, Lieber and Leatherwood (1978) found that only four samples (out of 300 bought in the San Francisco Bay area) had levels higher than 10 mg% with a maximum of 31.5 mg%. The high levels found in our survey may indicate storage of fish under conditions that allowed microbial growth and histamine production.

Moreover, although the precise level of histamine required to precipitate an outbreak of scombrotoxin poisoning is unknown, Simidu and Hibiki (1955) have suggested a minimum dose of 60 mg%, while Ienistea (1971) claimed that consumption of as little as 40 mg of histamine in a single meal will cause adverse reactions with the most sensitive individuals. The United States Food and Drug Administration has produced a compliance policy guide for albacore, skipjack and yellowfin tuna (U.S. Food and Drug Administration, 1980) stipulating that histamine levels of over 50 mg% should be regarded as a danger to health, while a batch would be considered to have decomposed, if more than two subsamples (of 24) have levels over 20 mg%. A lower level of 10 mg% is considered to be a suitable maximum limit by some experts (Arnold and Brown, 1978; Cann, Torry Research Station, Aberdeen, Scotland, 1984, personal communication). In this survey, the bulk of the samples had low histamine levels with 85.5% of the samples having less than 10 mg%. Twenty-six samples (10.5%) had levels within the 10-50 mg% range and should be classified as not from fresh fish or of low quality. Ten samples (4%) had toxicologically significant levels, above 50 mg%. Consumption of these samples should be considered as a health hazard. The presence of such levels suggests the possibility of mishandling of the fish during processing. Indeed, under the present conditions, the fish are subject to rough treatment. The fish are first handled when they are netted, hauled aboard the fishing vessel, and when the net is opened, allowing the catch to spill on the deck. Next, the fish are salted and shoveled into holds which are generally not iced or refrigerated. Hold temperatures average between 8° and 12°C (Folsom, 1977).

The fish are left to slosh back and forth in the hold until the vessel reaches port. The bottom layers of fish are usually completely mashed during the trip and can be used only for reduction to fishmeal. When the vessel reaches port, the fish are bailed out of the hold by men using small wicker baskets, dumped into plastic containers and sprinkled with a layer of salt. The containers are then loaded onto open trucks and are driven to canneries. By the time a truck is fully loaded, the sardines have been handled by many hands and have been out of the water for several hours. Therefore, these processing conditions provide a great potential for fish contamination, microbial growth and spoilage. Icing or refrigeration should be used in the hold and trucks to limit the fish quality loss. Also, thorough quality control procedures should be instituted to limit the microbial degradation and histamine development.

To study the effect of the factors, fish variety, fishing and processing area and fishing season, on histamine levels in canned fish, analysis of variance was performed on the data using the computer program ANVAM (Centre de calcul et d'informatique, Institut agronomique et vétérinaire Hassan II, Rabat). The results presented in Table 4 suggest that these factors did not have a significant effect ($\alpha = 0.05$). This lack of significance was felt to be due to different causes:

(1) It was found that fish caught in a given region are sometimes processed in canneries located in a different area. Moreover, central and northern canneries are occasionally supplied with fish caught in Tan Tan (Figure 1).

(2) Other factors such as the presence or absence of quality control programmes in factories might have interfered with the analysis. These factors were difficult to identify and take into account.

(3) Most importantly, the data were widely scattered (0 to 694 mg%) yielding an error term with a large mean square and therefore small Fs.

Table 3

Stem and leaf display of histamine levels in canned fish

Depth	Stems	Leaves
16	0.	00, 00, 00, 00, 04, 05, 06, 06, 09, 10, 11, 11, 12, 13, 13, 14,
32/	0.	14, 17, 19, 19, 19, 20, 20, 23, 26, 26, 26, 28, 30, 30, 30, 30,
48	0.	30, 32, 34, 35, 35, 36, 36, 37, 37, 38, 40, 41, 41, 42, 43, 44,
63	0.	44, 44, 44, 45, 48, 48, 48, 49, 50, 50, 52, 52, 55, 55, 57,
79	0.	58, 59, 60, 60, 60, 60, 62, 63, 65, 66, 67, 67, 68, 68, 69, 69,
96	0.	69, 70, 70, 70, 73, 73, 74, 74, 77, 78, 78, 80, 80, 80, 81, 84, 84,
103	0.	89, 90, 92, 93, 95, 97, 98
119	1.	00, 01, 03, 04, 04, 04, 04, 06, 07, 08, 10, 12, 12, 13, 17, 17,
17	1.	18, 20, 20, 20, 24, 25, 30, 30, 31, 32, 32, 33, 33, 35, 37, 37, 39,
112	1.	56, 57, 60, 68, 70, 74, 76, 79, 80, 81, 86, 86
100	2.	05, 11, 22, 23, 29, 38, 45, 45, 47, 49, 58, 58, 70, 78, 87, 91
84	3.	00, 07, 08, 15, 15, 15, 16, 32, 37, 50, 58, 60, 70
71	4.	23, 32, 40, 50
67	5.	00, 03, 04, 16, 30, 70, 70, 77, 88, 89, 90
56	6.	00, 00, 30, 454, 65, 65, 70, 72, 78, 90, 98
45	7.	00, 06, 47, 70
41	8.	
41	9.	07, 23
39	1	0.1, 0.9, 1.50, 1.70, 1.80, 2.21, 2.21, 2.46, 2.60, 3.44, 3.59,
28	1	3.60, 3.90, 4.00, 4.20, 4.36, 4.40
22	2	0.25, 2.00, 2.42, 4.40, 8.50
17	3	1.50, 2.50, 9.02
14	4	0.28, 2.41, 2.46
11	5	5.00, 8.80
9	6	9.20
8	7	
8	8	
8	9	0.70
7	1	01.70, 08.00, 11.60, 13.80
3	2	81.25
2	3	86
1	4	
1	5	
1	6	94.00

However, using tables allowed us to draw more information from the data. Table 5 shows the distribution of histamine levels for the different fish varieties. The high percentage (17.1%) of sardine samples with a concentration within the range 10-50 mg% could be due to the fact that sardines, delicate fish easily bruised, are caught and processed in large volumes: 150 000 t/year versus 13 000 t and 4 000 t/year for mackerel and tuna, respectively (Folsom, 1977). This would create more potential of mishandling for the sardines. Moreover, tuna showed the highest percentage of samples (7.0%) with levels above 50 mg%, suggesting that tuna is more susceptible to histamine development than mackerel or sardines, possibly because of its higher content of free histidine (Arnold and Brown, 1978).

Table 4

Analysis of variance

Source	d.f.	Sum square	Mean square	F
Period	1	317.48	317.48	0.102
Region	2	6 093.30	3 046.65	0.974
Variety	2	141.00	70.50	0.023
R X P	2	9 599.53	4 799.76	1.535
V X P	2	4 573.55	2 286.78	0.731
V X R	4	3 132.20	783.05	0.250
Residuals	234	731 842.75	3 127.53	
Total	247	755 699.75		

All Fs from given table were >3

Table 5

Distribution of histamine levels in Moroccan canned fish for different varieties

Range of histamine levels (mg%)	Sardines	Mackerel	Tuna
0 - 1.00	45.1[a/]	42.1	38.0
1.01 - 2.00	11.0	14.7	26.8
2.01 - 3.00	9.8	5.3	5.6
3.01 - 4.00	1.2	3.2	8.5
4.01 - 5.00	3.7	1.1	0.0
5.01 - 6.00	4.9	6.3	4.2
6.01 - 7.00	4.9	6.3	1.4
7.01 - 8.00	0.0	1.1	1.4
8.01 - 9.00	0.0	3.2	0.0
9.01 - 10.00	0.0	1.0	1.4
10.01 - 50.00	17.1	12.6	5.6
Above 50	3.7	3.2	7.0
Mean	9.75	13.74	9.86
Standard deviation	43.21	71.99	25.05
Range	00 to 386	0 to 694	0 to 113.8

a/ Percentage of samples within range

Table 6 shows the distribution of histamine levels for the different regions. There seems to be no effect of the area, possibly for the reasons mentioned earlier. However, the percentage of samples containing levels above 50 mg% was somewhat higher for the central region (7.1%) than the southern (4.3%) or the northern regions (1.3%), suggesting more mishandling of fish processed in the centre. The reason might be that canneries in the centre, or even the south, are supplied with fish brought in from Tan Tan in open trucks, often with no ice or refrigeration, offering greater potential for microbial proliferation.

Table 6

Distribution of histamine levels in Moroccan canned fish for different processing regions

Range of histamine levels (mg%)	North	Centre	South
0 - 1.00	38.8[a]	37.4	50.7
1.01 - 2.00	16.3	23.2	8.7
2.01 - 3.00	7.5	6.1	7.3
3.01 - 4.00	6.3	5.1	0.0
4.01 - 5.00	2.5	0.0	2.9
5.01 - 6.00	3.7	5.1	5.8
6.01 - 7.00	5.0	4.0	4.3
7.01 - 8.00	2.5	0.0	1.4
8.01 - 9.00	1.3	0.0	2.9
9.01 - 10.00	2.5	0.0	0.0
10.01 - 50.00	12.5	12.1	11.6
Above 50	1.3	7.1	4.4
Mean	6.40	12.60	19.21
Standard deviation	14.49	43.80	89.52
Range	0 to 108	0 to 386	0 to 694

a/ Percentage of samples within range

Table 7 shows the distribution of histamine levels for the different fishing periods. Contrary to what one would expect, fish processed during the high fishing season did not show higher levels of histamine. Furthermore, the percentage of samples of fish processed during the low fishing season and containing over 50 mg% was higher (5.5%). However, the average concentration of samples within that range (above 50 mg%) was much higher for fish processed during the high season (232.5 mg%), indicating a greater potential for mishandling than during the low season (142.0 mg%). Storage of the fish at ambient temperature before processing could explain these high levels of histamine.

Histamine development in "fresh" sardines was studied as a function of time, salt concentration and temperature. Linear regressions were fitted to the data using least squares analysis (Snedecor and Cochran, 1980). Zero and first order kinetics were evaluated by comparing correlation coefficients and performing analysis of variance to test the significance of linearity. In general, histamine development in the sardines was found to be a first order reaction (Figure 2). This confirms results reported earlier using mackerel (Smith et al., 1980) or dark fleshed fishes (Park et al., 1980). Rate constants were derived using the linear portion of the graph representing histamine levels versus time on a semi log scale, and the results are shown in Table 8. These data suggest that sardines are very susceptible to histamine development. Unacceptably high levels were observed only after three-five hours at ambient temperatures.

Present of bacteria, with high histidine decarboxylase activity, in large numbers could have been responsible for the rapid histamine development. The lag phase was usually short and the constant rates were much higher (10 to 20 fold) by comparison with data reported by previous authors. Because the fish variety, the ecological and environmental factors were different from one study to the other, it is difficult to determine with certainty the reason for these differences. However, one can speculate that the way the sardines were handled in Morocco before reaching the market has played a major role. They were out of the water for several hours with no ice or refrigeration, while in other studies the fish were frozen immediately after the catch.

The data presented in Table 8 and Figure 2 show that histamine development is much faster at high temperature and low salt concentration. Sprinkling the sardines with salt inhibits histamine accumulation somewhat. This effect is more marked at low temperature. Similar results were reported by Barhoumi (1980) who found that sardines stored in refrigerated sea water were more stable than iced fish. These data suggest that sprinkling fish with 5-8% salt and storage at temperature below 10°C could be efficient in increasing the shelf life by retarding microbial proliferation and histamine production. No histamine accumulated in the frozen samples.

At the present time, confirmatory studies on freshly caught fish are underway. These studies include also an investigation on the microflora associated with the spoilage of fish leading to histamine accumulation. This will allow us to devise satisfactory handling and quality control procedures to prevent potentially toxic fish from reaching the consumer.

Table 7

Distribution of histamine levels in Moroccan canned fish for different fishing seasons

Range of histamine levels (mg%)	High fishing season	Low fishing season
0 - 1.00	45.8[a]	37.5
1.01 - 2.00	18.3	15.6
2.01 - 3.00	6.7	7.0
3.01 - 4.00	1.7	6.3
4.01 - 5.00	0.8	2.3
5.01 - 6.00	3.3	6.3
6.01 - 7.00	5.0	3.9
7.01 - 8.00	1.7	0.8
8.01 - 9.00	0.0	2.3
9.01 - 10.00	0.8	0.8
10.01 - 50.00	12.5	11.7
Above 50	3.3	5.5
Mean	11.27	13.53
Standard deviation	64.34	45.49
Range	0 to 694	0 to 386

a/ Percentage of samples within range

Table 8

Rate constants for histamine accumulation in sardines for different temperatures and salt concentrations

Salt concentration (%)	Rate constant (hour $^{-1}$)			
	8°C	10°C	17°C	24°C
0		7.754×10^{-4}	1.788×10^{-3}	1.911×10^{-3}
2	6.705×10^{-4}	6.484×10^{-4}	1.665×10^{-3}	2.006×10^{-3}
5	5.740×10^{-4}	6.028×10^{-4}	1.627×10^{-3}	1.121×10^{-3}
8	4.210×10^{-4}	7.040×10^{-4}	1.663×10^{-3}	1.178×10^{-3}

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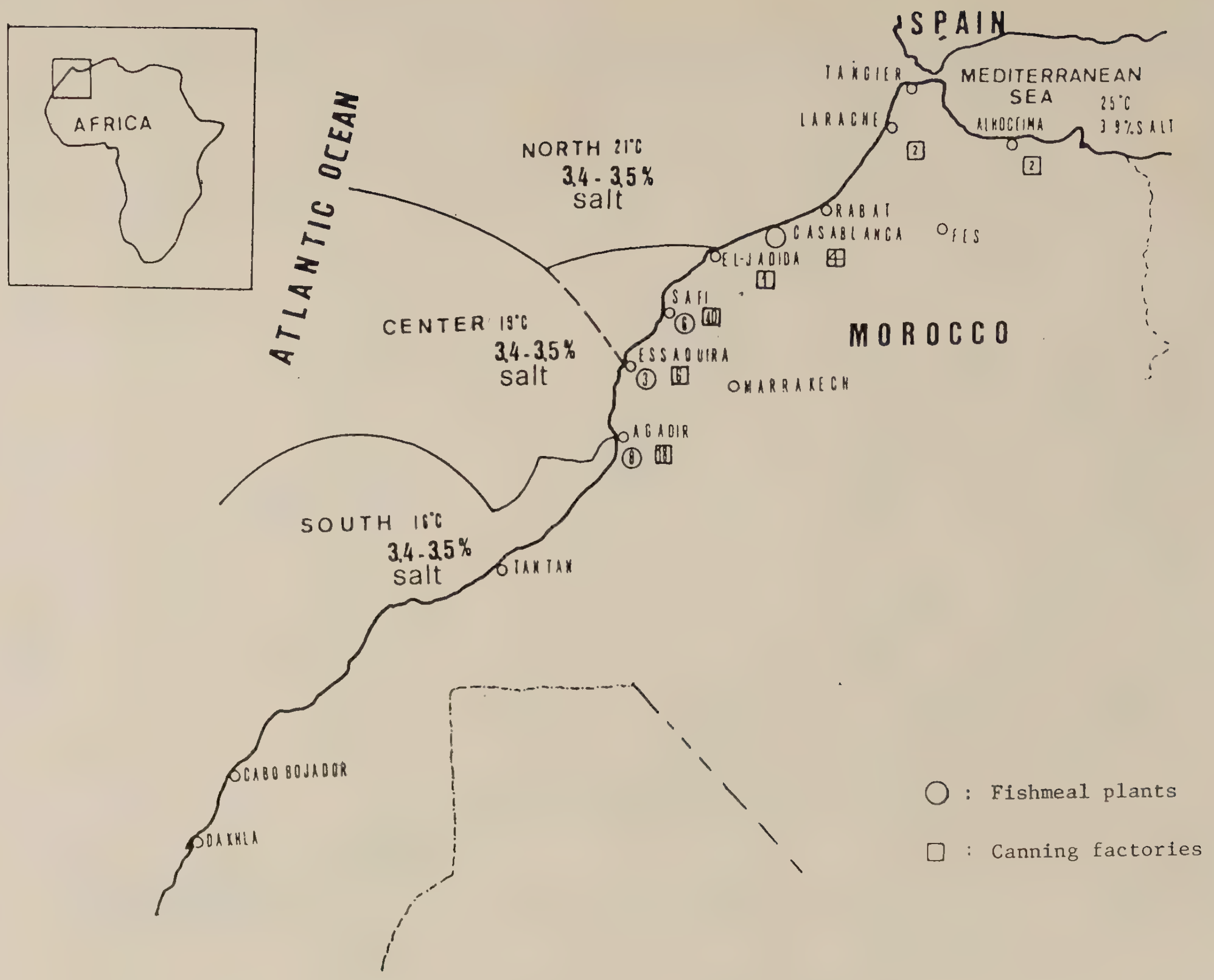
AFRICA
ATLANTIC OCEAN
SPAIN
MEDITERRANEAN SEA
25°C
3.9% SALT
TANGIER
LARACHE
ALHOCEIMA
2
2
RABAT
CASABLANCA
FES
EL-JADIDA
1
SAFI
6
40
ESSAOUIRA
3
5
MARRAKECH
AGADIR
8
18
MOROCCO
NORTH 21°C
3,4 - 3,5%
salt
CENTER 19°C
3,4 - 3,5%
salt
SOUTH 16°C
3,4 - 3,5%
salt
TAN TAN
CABO BOJADOR
DAKHLA
○ : Fishmeal plants
□ : Canning factories

Figure 1 Morocco's fishing ports processing facilities

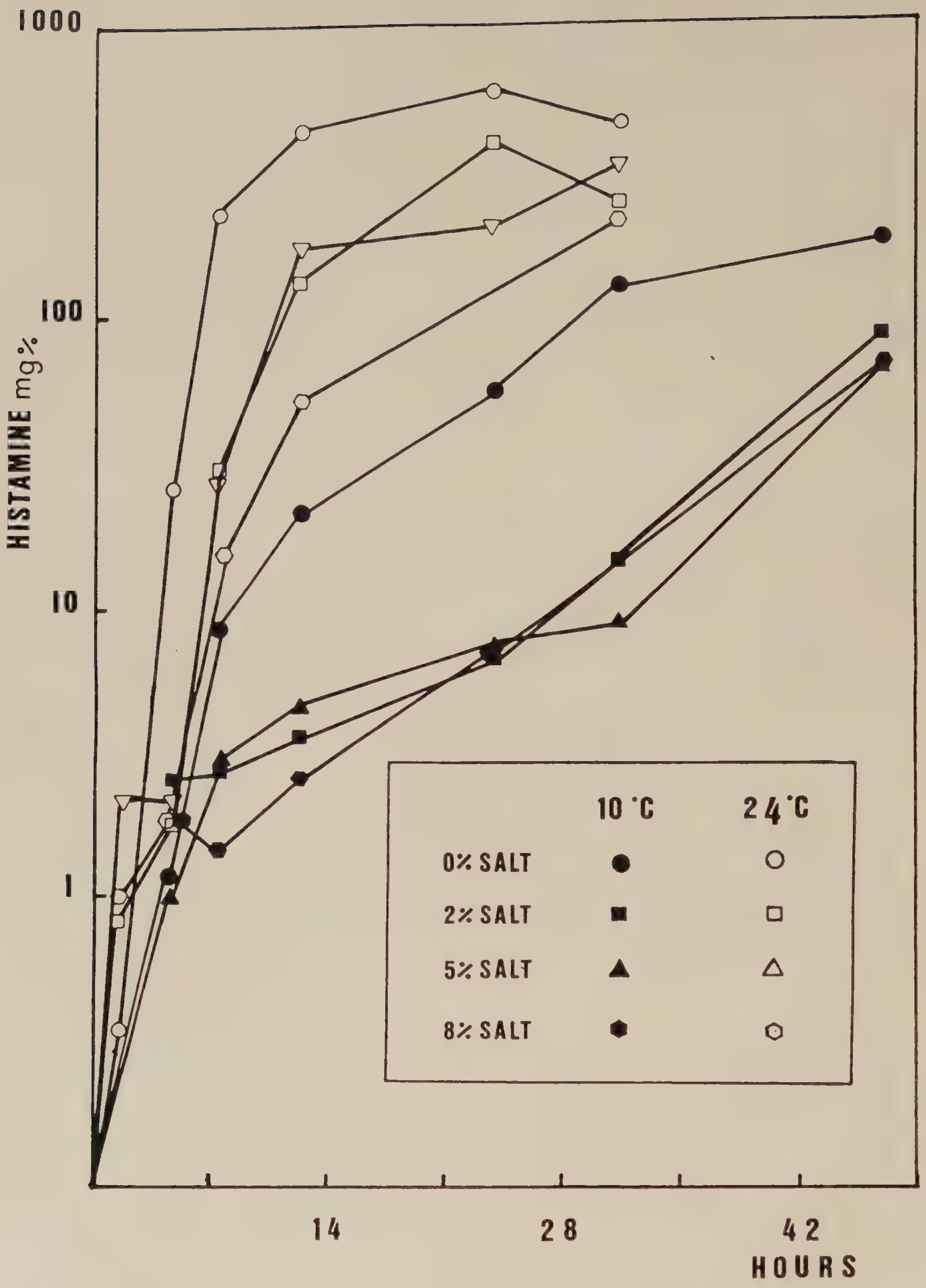

Figure 2 Effect of temperature and salt concentration on histamine development in "fresh" sardines

MERCURY CONTAMINATION LEVELS IN THE SHARKS OF THE MOZAMBICAN CHANNEL

by

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ABSTRACT

Inspection of the big carnivorous fish for mercury contamination has two objectives: (1) to evaluate the degree of contamination in fish used for human consumption; (2) to evaluate the level of Hg in the sea environment. This will provide information for the identification and the control of future occurrences of sea contamination in the area.

This study has permitted the establishment of a correlation between fish weight and Hg level for a determined genus of sharks, and also the mean value for each of the weight classes of sharks. It was shown that animals weighing 50 kg or more present a "non-acceptable" level of Hg and, therefore, this must be taken into consideration for the adoption of safety criteria for human consumption of fish. The follow-up of such studies will contribute to the monitoring of health risks and to the evaluation of control measures for this type of environmental contamination.

1. INTRODUCTION

1.1 General Aspects

Some heavy metals, at specific concentrations, are essential for a series of enzymatic activities. However, they form an important group of enzyme inhibitors when the normal concentrations are exceeded. Metals such as Pb, Ag, Cu, Cd, Hg are particularly toxic and inhibit enzyme activity when they form mercaptides with the sulphydryl groups responsible for the catalytic activity (Vallee and Wacker, 1970). Consequently the majority of the heavy metals are potentially toxic for living beings.

Marine organisms have the tendency to accumulate those metals that are normally found in low concentrations in the environment, but that can increase in the coastal areas and estuaries as a result of the development of industrial activity. To control the risks resulting from the increased concentrations of metals such as mercury in natural waters, preventive recognition is essential before damage to the environment becomes evident. However, the major problem is making a distinction between the natural levels in the environment and those produced by contamination.

It was calculated (Riley and Chester, 1971) that the levels of mercury in rivers are normally approximately 0.07 ppb and in oceans are approximately 0.05 ppb.

The most important sources of environmental contamination with mercury, related to industrial activity are: production of chlorine and alkali, electrical conductors, pesticides and pharmaceutical products. The world production of mercury increases 6%-7% every five years. The first example of contamination due to mercury was in Japan in 1965, in the Bay of Minamata, where 100 persons died by the ingestion of fish and shellfish contaminated with mercury (Irukayama, 1967). Other countries such as Sweden and more recently Canada and USA and various European countries have found areas contaminated with mercury. Through various studies it was possible to calculate that the highest values of this metal in different marine organisms are 0.4 ppm and 0.4 ppm in fish. In fish, more than 90% of the mercury is methyl-mercury; in shellfish, the values are between 40% and 90%.

1.2 Concentration and Environmental Exposure to Mercury

The concentration of mercury in the environment was fully examined by a Swedish technical group in 1971 and by the Joint Committee of FAO/WHO for Food Additives in 1972. The conclusions indicated that in practical terms there are no major problems resulting from the presence of mercury in air and drinking water where the levels are extremely low. The problems exist in fish, especially tuna, sharks and other carnivores in which concentrations of mercury may reach 5 mg/kg or more in contaminated waters.

The population in general runs practically no risk of ingesting methyl-mercury considering the average diet. The problem exists for populations that eat fish from contaminated locations or quantities of carnivorous fish which might cause the appearance of epidemic signs of intoxication, as were observed in Japan. The mean ingestion of mercury by individuals in the world population is below 20 μg/day; however, some groups can ingest daily doses 10 times as large (WHO, 1977).

1.3 Measures of Control and Standards for Foods

Several cases of poisoning by mercury were due to the accidental consumption of seeds treated with organo-mercurials with fungicidal action. The toxicological risks demand measures of security which in some cases, especially in developing countries, do not always produce results; however, they are necessary to protect the consumer.

Many countries have adopted maximum acceptable levels of mercury in fish destined for human consumption and made recommendations about the frequency of fish consumption. The limits for mercury in fish vary between countries from 0.1 mg/kg to 1.0 mg/kg with a level of 0.5 mg/kg as the most frequent value. Table 1 (Lu, 1973) shows the tolerated mercury levels in fish in some countries. The permissible daily intake of mercury for humans, fixed by the Codex Alimentarius Committee, corresponds to 5 μg/kg of body weight.

Table 1

Summary of some current permissible levels of mercury in fish

Country	Maximum permissible mercury level in ppm	Remarks
Federal Republic of Germany	0.1	Maximum permissible in all food including fish products
	0.5	Specific tolerance for dogfish, tuna, and swordfish
Belgium	0.5	
Canada	0.5	Administrative guideline
New Zealand	0.5	
Spain	0.5	
USA	0.5	Administrative guideline
France	0.7	Provisional
Italy	0.7	Only for imports
Denmark	1.0	
Japan	1.0	Administrative guideline
Sweden	1.0	Based on one meal of fish per week

Source: Lu, 1973

There is no information about the residues of mercury in fish captured in the Indian Ocean and considering the increase in the production of processed shark for local consumption it was necessary to start a study programme to verify mercury levels and to control the development of the residues of mercury in the following years.

2. MATERIAL AND METHODS

Samples were furnished by the "Instituto de Investigaçao Pesqueira, Departamento de Tecnologia do Pescado", and refer to different species of sharks caught in the Mozambican Channel.

Samples were taken from the dorsal region of the fish before processing and delivered frozen at -20°C. Along with the samples, data were sent about the name of the species and the weight and length of each specimen. The length was calculated as: the length of the body, plus length of the superior lobule of the caudal fin corrected with a factor of 0.8 (Bass, D'Aubrey and Kistnasamy, 1975).

The samples frozen at -20°C were thawed and mineralized with nitric, sulfuric and perchloric acids (AOAC, 1975). After digestion, the concentrations of mercury in the samples of sharks were determined by flameless atomic absorption spectrophotometry. For this last operation a Varian 475 spectrophotometer with a "Model 65 Vapor Generation Accessory" was used.

The conditions of the analysis were:

Wave length: 253.7 nm
Double beam
Intensity of lamp: 4 mA
Split: 0.5
Carrier gas: N_2 at 1.4 kg/cm^2

To eliminate the matrix, a standardization was done by the internal standard method using fish without mercury (Figure 1). The sensitivity of the method was calculated 0.4 µg/l mercury.

3. RESULTS

In Table 2 we express the data of weight, length and levels of mercury (in mg/kg) corresponding to the different species of shark most frequently seen. It is estimated that 200-250 species exist, divided into 20 families. The quantity of shark captured in the Indian Ocean varied between 41 200 t in 1970 and 43 651 t in 1976 (Kreuzer and Ahmed, 1978). The western area is the most important, accounting for 80% of the total production of the Indian Ocean. The most common shark family is the Charcharhinidae, whose capture reached 22 000 t in the last few years.

As the parameters for each sample were length and weight, we calculated the correlation coefficient between those values to verify if in all species examined the length increased proportionately with the weight. As can be seen in Figure 2, only one species (Mustelus punctatus) has a somewhat different length-to-weight proportion in relation to other species. We did not encounter a significant correlation between length weight and/or levels of mercury in the species analysed.

In various countries publications point out generic classification of sharks without indicating the species. It has been shown that sharks accumulate mercury and that the levels increase progressively with age. Sharks have a long life and continue to increase in weight. The differences between species, in relation to the growth, voracity and migratory characteristics, are important parameters that do not permit definition for all species in terms of relationship between weight, length and levels of mercury. However, through examination of only one genus, Carcharhinus, it was possible to find a significant correlation between body weight and the levels of mercury.

The mean values of mercury for each weight class (Table 3) show how the levels increase in the different classes. This fact is better noted in Figure 4.

From this data we can conclude that sharks with weight less than 14 kg have levels of mercury corresponding to the maximum limits of acceptability permitted by the majority of countries worldwide. Sharks weighing 50 kg are the maximum weight permitted in some countries that have problems with mercury contamination of the water. In the last class, in sharks weighing more than 50 kg, the levels found are considered unacceptable in all countries. From this data we also find that the liver has an accumulation of mercury two or three times as high as that of the meat for the same specimen.

4. DISCUSSION AND CONCLUSIONS

The FAO recommends control of mercury in sharks whenever a country plans the development of a programme to catch and utilize shark for consumption. Our work was no more than the application of this recommendation, taking into account that shark meat is rich in proteins as compared with other fish, and greatly contributes to nutritional improvement.

According to the results obtained, the first important consideration is that there is a significant quantity of mercury in these marine waters; this fact should be analysed additionally, to verify the causes. The mercury could have originated in Mozambique or be caused by the industrial activity of other countries of the region. The continuation of this study should permit verification, principally in the next few years, of whether levels of mercury will tend to increase. Often

Table 2

Data of weight, length and levels of mercury for the different species of sharks analysed

Sample Number	Species	Weight (kg)	Length (m)	Hg (mg/kg)
1	*Galeocerdo cuvieri*	55	1.55	1.76
2	*G. cuvieri*	65	1.68	1.70
3	*G. cuvieri*	70	1.95	0.78
4	*Carcharhinus maculipennis*	40	1.68	1.02
5	*C. maculipennis*	42	1.65	1.35
6	*Carcharhinus brevipennis*	34	1.55	0.82
7	*C. brevipennis*	55	1.77	2.59
8	*C. brevipennis*	10	0.96	0.73
9	*C. brevipennis*	28	1.25	1.52
10	*C. brevipennis*	40	1.91	1.49
11	*Sphyrna lewini*	41	1.67	0.51
12	*S. lewini*	7	1.08	0.37
13	*S. lewini*	120	2.69	1.78
14	*S. lewini*	9	1.21	0.68
15	*Mustelus punctatus*	50	2.61	0.51
16	*Phizoprionodon acutus*	21	0.91	1.48
17	*Carcharhinus milberti*	59	1.83	0.69
18	*Carcharhinus limbatus*	53	1.83	1.29
19	*C. limbatus*	6	1.02	0.56
20	*C. limbatus*	3	0.86	0.37
21	*C. limbatus*	9	1.06	0.54
22	*C. limbatus*	35	1.49	1.24
23	*C. limbatus*	15	1.13	0.52
24	*Carcharhinus obscurus*	44	1.70	0.69
25	*C. obscurus*	26	1.43	0.96
26	*C. obscurus*	45	1.70	1.58
27	*Sphyrna mokarran*	193	2.99	0.60
28	*Rhynchobatus dseddewsis*	20	-	0.55
29	*R. dseddewsis*	42	1.83	0.35

Table 3

Mean Values of Hg by Weight Classes

Number of Samples	Weight (kg)	Mean Values of Hg (mg/kg)
7	< 15	0.54 ± 0.14
14	16-50	1.00 ± 0.44
8	> 50	1.40 ± 0.69
2	Liver	1.70 ± 0.08

the resolution of these problems is not possible at the national level and requires the participation of all the countries of the region.

In reference to the future development of the exportation of shark, we consider that sharks weighing more than 50 kg will not be accepted by the majority of countries. We also think that the presence of mercury in the shark meat is not a major problem because it is only a small part of the local diet and is not likely to put the consumer at risk; however, some groups of the population that utilize great quantities of shark meat in their diet might eventually be at risk of accumulating mercury.

The continuation of such studies will be the best way to monitor the development of this contamination in the future to preserve the natural resources of the country and to prevent harmful effects in the population.

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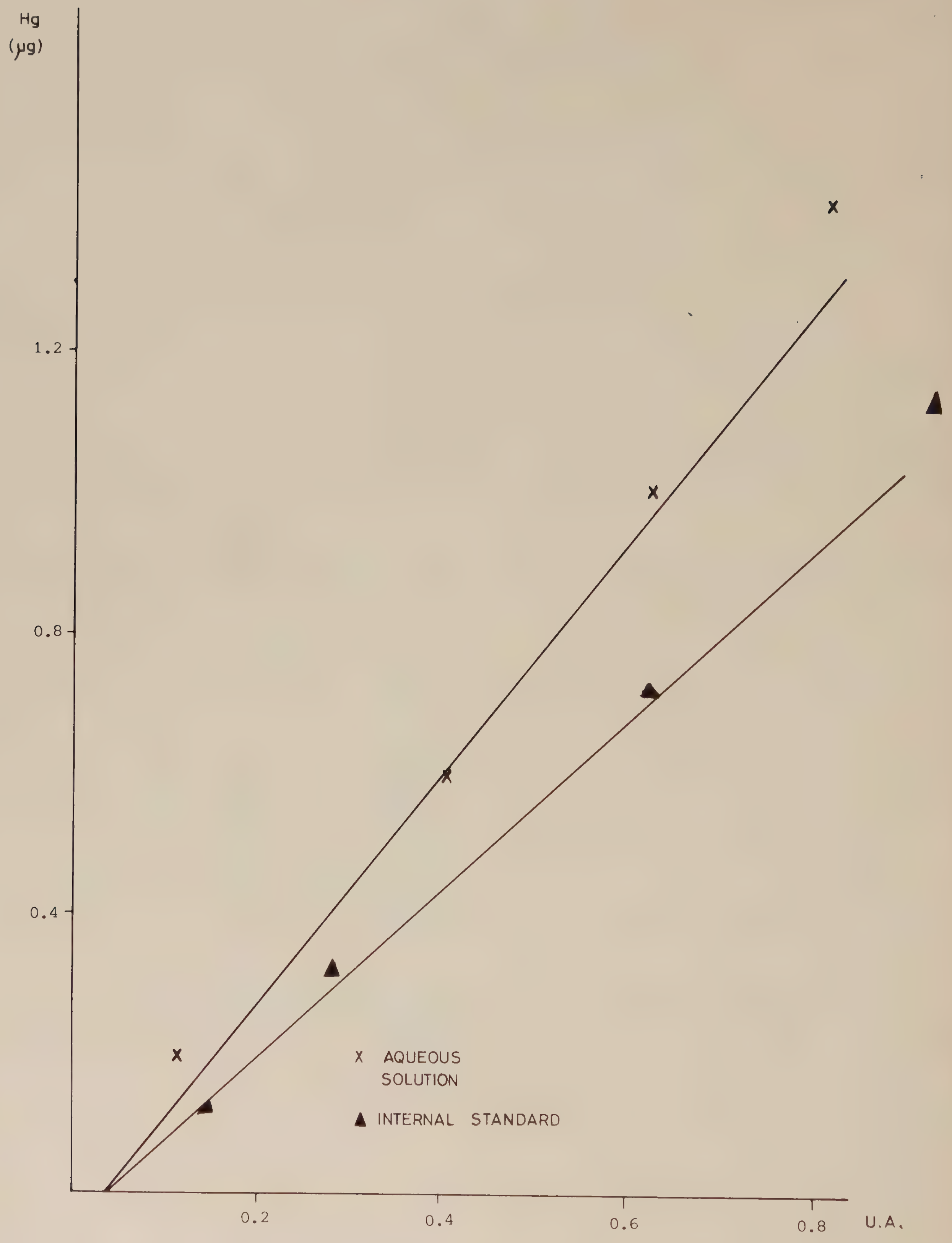

Figure 1 Standard curve for mercury

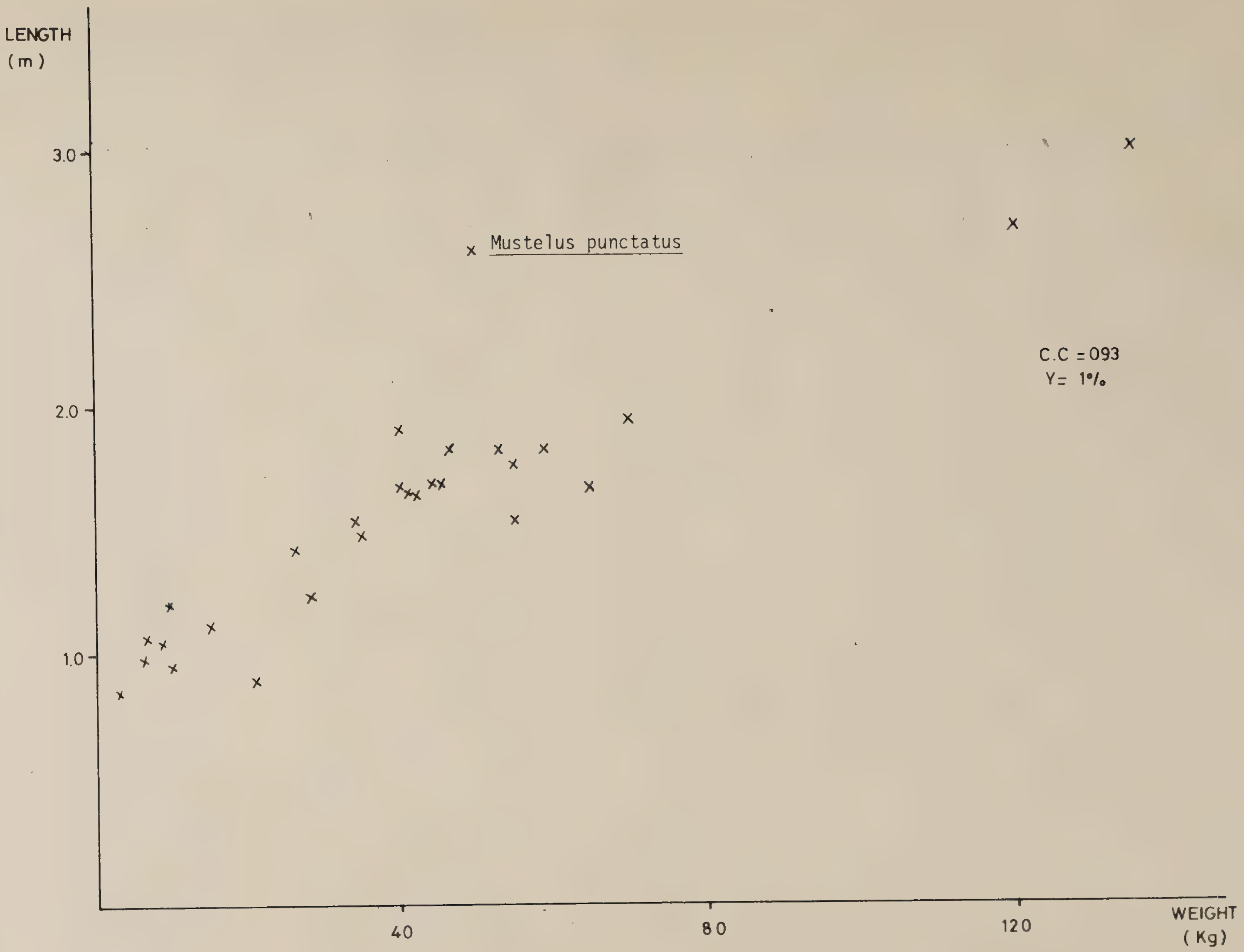

Figure 2 Correlation between weight and length in sharks

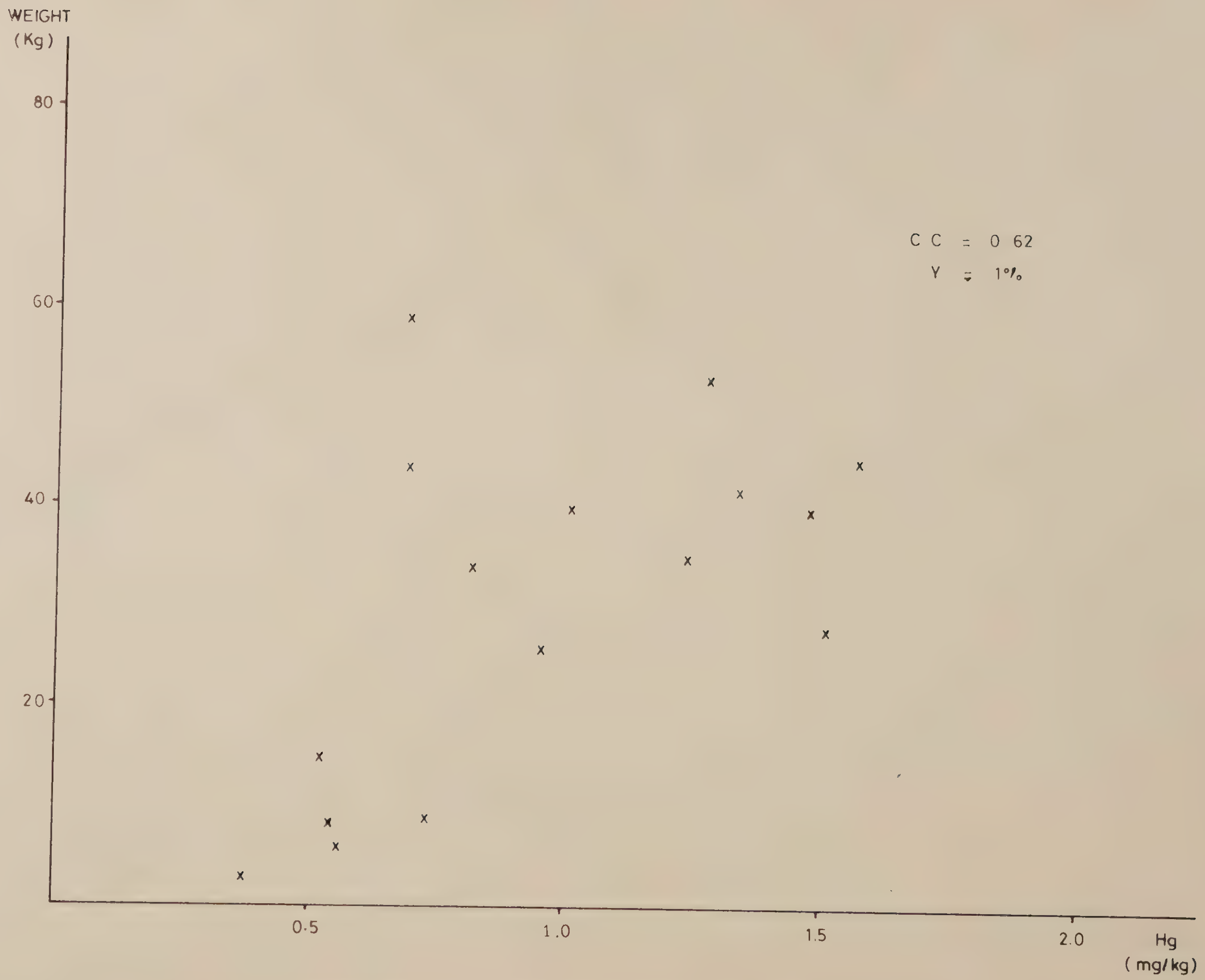

Figure 3 Correlation between weight and levels of mercury in the genus Carcharhinus

SESSION 6:

OTHER PROBLEMS/AUTRES PROBLEMES

PRESENT STATUS OF FISH TECHNOLOGY TRAINING IN TANZANIA

by

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ABSTRACT

Fisheries training in Tanzania dates back to 1967 when the Kunduchi and Nyegezi Fisheries Institutes were established. The training offered has some element of fish technology.

The paper reviews the relevance of the fish technology training offered in the country. It examines the appropriateness of the training to the needs of small-scale processors and goes on to recommend the need to restructure the training to meet the needs of the small scale processors.

1. INTRODUCTION

Fisheries training in Tanzania dates back to 1967 when the Kunduchi Fisheries Institute was established to offer a Diploma in Fisheries. In 1965, the Ministry of Agriculture Training Institute at Nyegezi, Mwanza, had introduced a Fisheries certificate course to cater for the fisheries section extension staff requirements. The student intake was limited to 20 for the Kunduchi Institute and to 10 for the certificate course. The course content was of a general nature with about 20% of the time allocated to fish processing and quality control theory and practice. The Institutes have continued to offer the courses with modifications to fit changes in the industry. The course graduates are absorbed by the regional administration, training Institutions, research centres, fishing companies, parastatals and the divisional head office where they perform duties ranging from fisheries administration, management, development planning, statistics, research and extension service.

1.1 Need for Training in Fish Technology

The expansion of the fishery industry in Tanzania has resulted in increased losses of fresh fish due to spoilage caused principally by lack of facilities for immediate chilling of the catch combined with poor handling, storage distribution and marketing. An estimated 10% of fish is lost every year by the small-scale fishermen who contribute over 95% of the landed catch of over 260 000 tons per year (1983). Traditionally processed fish suffer losses of between 10 to 40% as a result of insect infestation and physical deterioration during and after processing. The Kunduchi and Nyegezi trained extension staff were with time found unable to cope with the technical problems of fish spoilage and loss reduction.

The small-scale fishermen lack the technological awareness needed to realize good quality of processed fish. The canoe fishermen usually pay little regard to conserving their catch and instead throw it haphazardly into the bottom of the canoe. They do not gut any large fish immediately after it is caught and do not take measures to shield the fish from the direct rays of the sun. Fish technology training for fishermen is vital.

In an effort to reduce fish losses, fish technology training was incorporated in the technical diploma courses initiated at Mbegani Fisheries Development Centre with NORAD assistance. The course is of two years duration and covers different aspects of fish processing (traditional and conventional), quality control, industrial sanitation, fish marketing and distribution, plant lay-out and economics for fish technologists. The course is supported by industrial practice which enables the student to learn practically by being involved in fish processing operations. In this way the student is able to learn by experience industrial problems and how to plan for their elimination. The centre also conducts one-year fish technology courses for experienced field attendants who return to their original working stations and participate in imparting the knowledge gained to the fishermen.

1.2 State of Fish Technology Training

Fish technology training occupies about 23% of the total time at Kunduchi and Nyegezi. At Kunduchi fish technology has a total of 340 hours in two years of which 40% is practical training. The main subject areas are handling of fresh fish, spoilage, processing (traditional and conventional), microbiology, quality control and industrial sanitation. These are supported by training in marketing and distribution, economics, statistics, principles of extension service, fisheries cooperatives, and fisheries management and administration.

The Nyegezi Institute has the same structure of fish technology training as the Kunduchi Institute with the main difference lying in details of coverage of the courses. Nyegezi is meant to supply the bulk of the extension staff requirements.

The Mbegani fish technology training is of two years duration with a total time of 2 400 hours out of which 75% is available for full fish technology training. In addition courses in economics, marketing, statistics, first aid, fisheries management and administration and accounts are conducted to support the main subjects. Industrial training and field practice take up 32% of the time

allocated for fish technology training.

1.3 State of Trained Fish Technologists

Presently the fisheries sector employs a total of 989 staff biased towards fish technology of different categories as shown in the table below:

List of fish technology oriented staff

Professional University training & additional training	Certificate course training Nyegezi	Kunduchi training institute diploma	Mbegani fish processing diploma	Field attendants Primary School on-job training
3	296	171	10	519

Source: Fisheries Division Manpower Records 1984

Although a total of 989 staff are supposed to participate in fish technology extension services, it is observed that the field attendants who form an estimated 42% of the active staff are inadequately trained and spend more time on fishing, statistics collection and aquaculture which are not related to fish technology.

The trained fish technologists attached to government and parastatal offices have been absorbed in administrative tasks with very little reference to fish technology. Those attached to research centres and training institutes have no working tools to enable them to participate fully as effective fish technology extension workers.

1.4 Fish Technology Training Policy

The fish technology training policy stresses the need to develop ways and means to improve traditional fish processing methods in the country with the ultimate objective of reducing fish losses and making more high quality protein available to the needy population. The training is meant to provide technically qualified manpower for the fisheries and allied industries with emphasis on importing practical skills.

Personnel performing duties on fishing vessels like skippers and marine mechanics are given short courses in fish technology to enable them maintain the quality of their catches. Since the trained personnel do not work on the traditional non-powered vessels used by the small-scale fishermen, their influence on the quality of the catch is negligible.

1.5 Problems Affecting Fish Technology Training

Training in fish technology has so far been based on meeting the manpower needs of commercial or large scale operations of the industry. Training has been affected by lack of adequate training facilities at Kunduchi and Nyegezi Institutes. Mbegani Fisheries Development Centre is well equipped for conventional fish technology training. The major drawbacks of the training offered in the country and outside the country is that it may not be relevant to the needs of the small-scale fishermen who land the bulk of the catch and operate from isolated landing centres. These fishermen land small quantities of fish and lack the ice to chill the fish immediately after it is landed. The adverse economic situation has made it difficult for the nation to keep in working condition. Ice production and cold storage facilities established in different parts of the country for preserving and maintaining the quality of fresh fish. In some areas ice and cold storage facilities cannot be operated due to lack of adequate quantities of electricity. In some other areas the fish receiving stations established as part of a national cold chain operation for distributing fish have not worked since they were constructed like the one at Kibizini Kigoma on Lake Tanganyika.

The fisheries sector is unequipped to absorb personnel trained on modern machinery because such technology is of limited use under the prevailing economic situation and does not therefore meet the needs of the small-scale fishermen who is the main fish producer. The trained fish technologists find themselves out of place in dealing with the extension service needs of the industry.

1.6 Summary, Recommendations and Conclusions

Fish technology training is supposed to cover the operations from the time the fish is removed from the water to the time it reaches the consumer. Training has to correspond to the state of development of the industry. It should as far as possible aim at improving the performance of the small-scale fishermen who at times fish and process the catch using simple techniques locally developed in the village. They sometimes use a log of wood, a water bucket and a knife to carry out the scaling, gutting, splitting and washing operation. The fish so prepared is then processed by sundrying or smoke dried in traditional smoking kilns.

Training should in this case aim at developing the traditional fish processing techniques to reduce contamination and spoilage of the fish. A model for small-scale fishermen to use in scaling, gutting, splitting and washing of the fish can be developed from locally available materials. This innovation will assist in maintaining high quality, it will be cheap, convenient to use, easy to maintain and keep clean. Considering the mobile nature of some small-scale fishermen, fish technology training should provide for techniques which can be applied in remote areas. In the absence of ice, traditional fish preservation by sundrying, smoke-drying or a combination of smoking and sundrying should be stressed. Improvements on these methods will be more acceptable since they are within the reach of the small-scale fish processors.

The main operations requiring maximum attention in fish technology training are:

(a) fish landing, storage and transport to ensure that damage to the fish is minimized and spoilage of the fish eliminated. Use of locally developed containers to transport fish should be emphasized;

(b) fish processing methods: the methods should be simple, cheap, easy to use and acceptable to the small-scale fishermen;

(c) fish marketing and distribution arrangements: presently the fish marketing arrangements are in the hands of private traders who operate from the fish landing beaches. The prices are fixed by direct negotiations between the fishermen and the fish traders - mainly referred to as fishmongers. The fishmongers are responsible for distributing the fish to the consumer. The consumer prices are very high and bear no relationship to quality and protein value. The training component of fish marketing and economics should aim at eradicating the problem of high prices by ensuring the consumer pays for a fair share of quality protein.

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